REPORT RESUMES

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CURRICULUM GUIDE IN CONSERVATION EDUCATION.
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THIS CURRICULUM GUIDE PRESENTS CONSERVATION OF NATURAL RESOURCES AS AN INTEGRATED NATURAL SCIENCE STUDY. NATURAL RESOURCES ARE SEEN AS BEING INORGANIC (MINERALS, AIR, WATER, AND SOIL) OR ORGANIC (PLANT, ANIMAL, AND HUMAN). THESE RESOURCES ARE PRESENTED AS SUGGESTED CLASSROOM ACTIVITIES DESIGNED FOR THE PRIMARY, INTERMEDIATE, AND JUNIOR HIGH STUDENTS. VOCABULARY LISTS AND BIBLIOGRAPHIES OF BOOKS, PAMPHLETS, FILMS, FILMSTRIPS, AND OTHER AIDS ARE INCLUDED. (FS)

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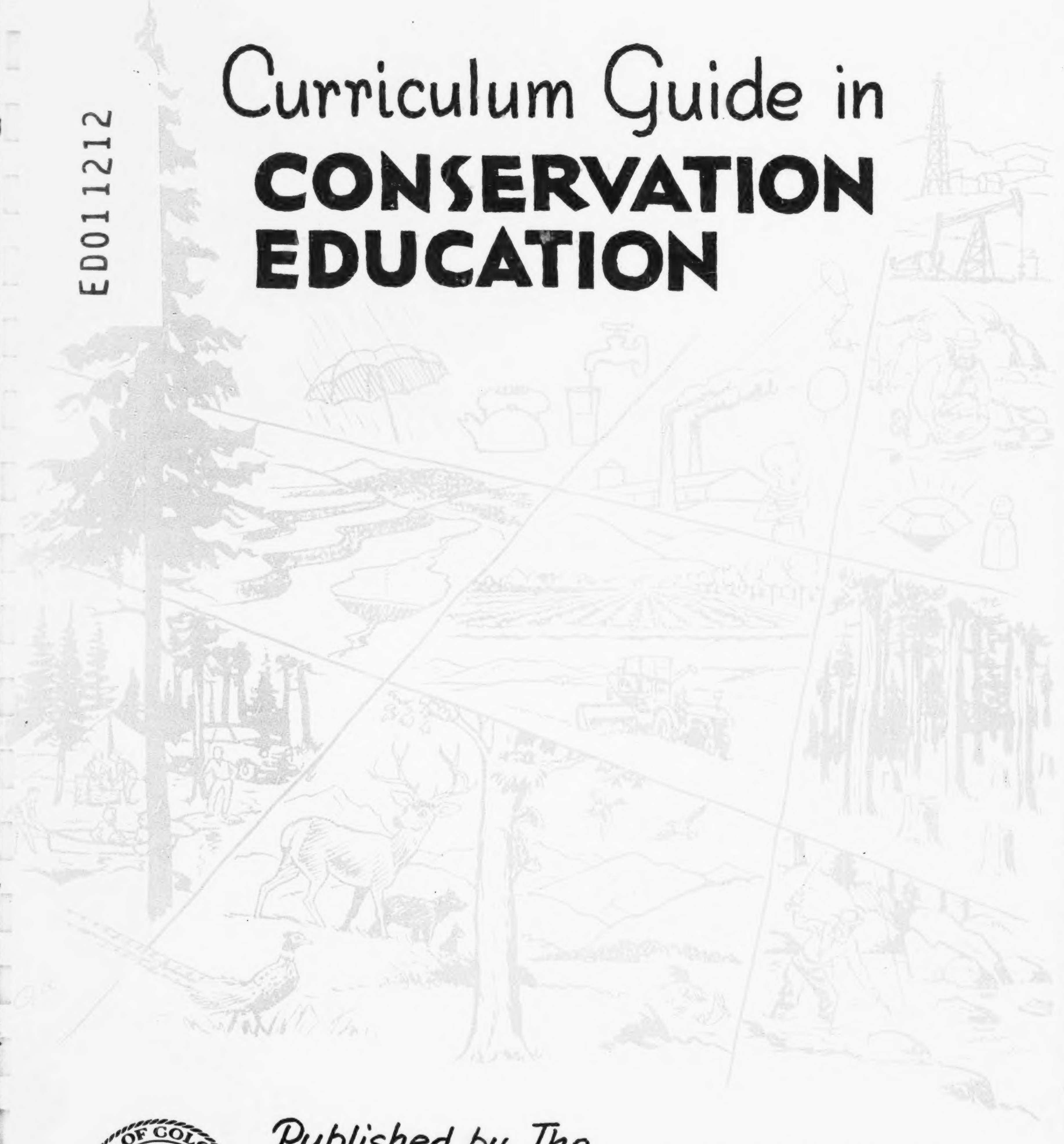
# Curriculum Guide in
# CONSERVATION EDUCATION



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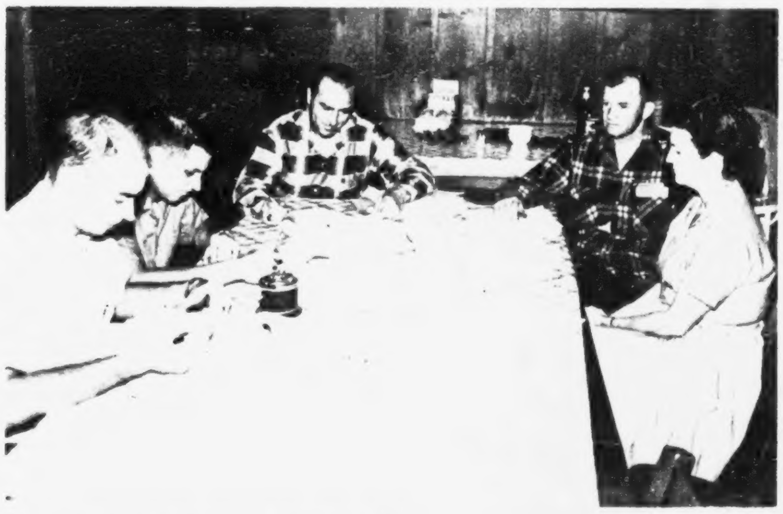
HARRY R. WOODWARD, DIRECTOR. DENVER, COLORADO 1964

RC 000 453

Persons who attended the Life Science Workshop at the University of Colorado's Science Lodge are shown at the left.

The photo below shows five people who worked on the Guide at the Conservation Education Workshop held at Manitou Forest.



These persons also served on the editing committee of the Curriculum Guide. They are working while attending the Conservation Education Workshop, at Manitou Forest.

One activity of teachers who attended the Life Science Workshop at Beulah, Colorado, was to collect samples of life under the rocks.

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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# Curriculum Guide in Conservation Education

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April 1964

ALFRED M. POTTS, 2d

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# FOREWORD

The ever-increasing needs of our growing population have made the conservation and wise use of our country's natural resources a topic of national concern. Because of this, conservation education has achieved new importance in the public school curriculum.

This guide presents major concepts in Conservation Education and suggests activities to teach these concepts. It anticipates that you can integrate these in science, social studies, English, and other classes. Outdoor education and camping experiences, field trips and visual aids, all vital to a successful program, are included. References to help the teacher make an effective presentation are listed by resources and grade level.

We are indebted to many groups and individuals who helped prepare this Guide. Special commendation should go to the Colorado Advisory Committee on Conservation Education which proposed and gave impetus to the project, to the many teachers who contributed time and experience, and to the Colorado Game, Fish and Parks Department for counsel, editing, and art work. We also want to thank members of the Department of Agriculture, Soil Conservation Service, U. S. Forest Service, and Colorado Bureau of Mines for their help.

Byron W. Hansford
Commissioner of Education

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# ACKNOWLEDGMENTS

The Colorado Advisory Committee on Conservation Education began the initial work on a conservation curriculum guide at a two-day meeting at the Manitou Experimental Forest in May, 1961. A second meeting took place in May, 1962, for the purpose of formulating a preliminary outline for the guide. Persons attending these sessions included members of the advisory committee, representatives from various resource agencies, and delegates to the 1962 meeting of the national classroom teachers at all grade levels who were selected for their interest and demonstrated ability in conservation education.

We would like to acknowledge the following as being instrumental in the preparation of this Guide:

**Teachers' Writing Committee**

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**The National Department of Classroom Teachers' Workshop at Gunnison, Colorado, July 1962.**

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Excerpts from the

# White House Conference on Conservation

May 24-25, 1962

It was President Kennedy's view that the land depends *upon us* as much as we depend *on the land*. "Conservation," the President said, "can be defined as the wise use of our natural environment; it is, in the final analysis, the despoilment while preserving, improving and renewing the quality and usefulness of all our resources."

Until the time of Theodore Roosevelt who boldy asserted the people's interest in resource management and his vigorous attacks on the wasters slowed the pace of plunder, little thought was given to the public interest in conservation. As stated by Secretary of the Interior, Stewart L. Udall, "Man's stewardship began on this continent in the tenancy of a pastorial people. Our forebears lived hard and simple lives. They subjugated the forests, built their own homes, and drew sustenance from the fields, orchards, and livestock they tended. Their power to alter the land was the power of the horse and the strength of bare hands. This primitive period gradually ended, however, when invention made it possible for men to organize the wholesale harvesting and marketing of their resources. From the outset Americans were obsessed with the idea that nature's bounty was superabundant . . . We conducted a single-minded raid on wildlife and timber and grass and even on the soil itself—before we awoke to the fact that we were squandering the birthright of our children." Udall reviewed the progress made in the past hundred years as follows:

*The Homestead Act of* 1862—which has become the classic American contribution to land reform;

*The Yellowstone Park Act of* 1872—which was the beginning of the idea that the most superb of our scenic lands should become parks for all of the people;

*The Forest Reservation Act of* 1891—which enabled Harrison, Cleveland, and Theodore Roosevelt to establish our national forest reserves;

*The Reclamation Act of* 1902—which meant that water would be conserved and its benefits widely shared in the arid regions of the West;

*The Antiquities Act of* 1906—which gave Presidents the power to establish national monuments;

*The Weeks Act of* 1911—which established the system of national forests in eastern United States;

*The Mineral Leasing Act of* 1920—which set up an orderly plan for the development of our mineral wealth;

*The Soil Conservation Act of* 1935—which started a nationwide program of soil and moisture conservation, and

*The Taylor Grazing Act of* 1935—which closed the public domain and put our grasslands under sound management.

Secretary Udall continued with these challenges:

"The goals and purposes of President Kennedy's conservation program give us a clear concept of the dimensions and complexity of our problems. Let me summarize some of them:

— Exploit science to create new resources and enlarge the use of existing resources;
— Give new vigor to traditional programs;
— Unlock the resources of the sea;
— Reserve for their high human uses the remnants of the American wilderness;
— Establish a land conservation fund to assure the acquisition of key conservation lands;
— Wage an all-out attack on water and air pollution;
— Help cities save open space and plan their growth;
— Grow adequate timber supplies for future needs;
— Save the remaining shoreline for public use;
— Learn to husband fresh water, and seek the means of extracting it from the sea;
— Plan now the water development of all river basins;
— Preserve a viable habitat for waterfowl and wildlife;
— Mount a vigorous campaign with invigorated state and local participation to enlarge the opportunities for outdoor recreation;
— Earmark military reservation lands as an ultimate conservation reserve for Federal, State and local governments;
— Establish a youth Conservation Corps to work in the vineyard on most of these problems; and above all
— Share our conservation know-how and conservation ethics with men everywhere."

Secretary of Agriculture Orville Freeman stressed the need for the development of recreation facilities on private lands and pointed to examples of profitable income to the landowners. The Department of Agriculture provides plans and consultant service to landowners who wish to develop recreational areas.

Laurance S. Rockefeller, Chairman of the Outdoor Recreation Resources Review Commission, in discussing the values of government aid in city development planning said, "It is the environment of the homes and the American people which concern us more than anything else, for the good reason that the character and well-being of our young people are directly related to this environment. Nobody can minimize the importance of *fresh air, pure water, fertile soil, growing things*—whether these be *grass and trees* or *birds and animals*—and I think it is wonderful and exciting that this program of open-space land, with accompanying grants, is now available as an effective tool, not only to emphasize this importance and need, but to do something about it."

# Introduction

**An over-all look:**

Each acre of land is capable of supporting an interdependent community of plant and animal life, and yet every acre is also a potential wasteland. By wise use of natural resources, by progressive conservation methods and by intelligent and responsible actions on the part of the citizens of the earth, old wastelands can be reclaimed and deterioration of the present oasis prevented. But by lack of knowledge about natural resources and their conservation, by irresponsible destruction and pollution of resources and by mere apathy to the problems of conservation, humans will cause deserts to move in on them like a tide of lava. Through an effective program of conservation education, we, the people, can learn what we are doing to ourselves, and perhaps we may recognize the need to prevent the misuse of natural resources. We must first, however, understand the nature of resources in order to solve any problems of their conservation.

**Feelings, appreciations and attitudes:**

The immediate problem of instruction in the primary grades of the schools is to lay the groundwork for feelings, appreciations and attitudes toward the earth's basic resources. Students must learn that as resource users they must also accept the responsibilities of resource savers. Thus, conservation education has three duties: to teach the scientific nature of the resource; to show in what ways each individual depends upon his natural environment; and to show each individual specific ways in which he can actively practice conservation—from disposing of litter in proper places to helping in a school tree-planting program.

**For the good of all:**

Even though the teaching of conservation relies primarily on scientific fact, it is important to realize that conservation is a combination of scientific, economic and ethical relationships, and studying one element without the others would give a one-sided view of the whole problem. For a conservation program to be successful, individuals must realize that picking up their own refuse as well as the cans and papers of others is important in maintaining a sense of self-respect and respect for the beauty and usefulness of the natural surroundings. Yet in countless situations there are those who rebel at the very thought of conserving the beauty and purity of nature for others. In these individuals we need to develop a sense of responsibility; they must learn that conservation practices are beneficial, helpful, enjoyable, and that a disregard for them is a threat to human survival.

**Knowledge—not enough:**

Merely teaching the scientific facts of conservation will not produce responsibility; nor will preaching the doctrine of "good and bad." What is necessary is for teachers and students to develop a real feeling of appreciation for the gifts of nature implemented by a thorough understanding and application of scientific practices. Knowledge and responsibility are the two most important tools for a student if he is going to take part personally in conserving natural resources for society.

**Need to affect behavior:**

The purpose of a conservation curriculum guide is to bring together ideas for managing and taking care of our natural resources which will build good attitudes and behavior patterns toward them. The guide is designed to help explain why conservation is necessary and to show how government, private organizations and individuals may practice conservation. The guide is, of course, only a suggested outline of the most important elements of conservation education. Fitting this outline into the instructional program in such a way as to affect the attitudes and behavior of children is the responsibility of the teacher. This can be done through activities in science, social studies, and English.

Teach and use the Conservation Pledge on the back cover.

**The natural resources and outer space:**

In these days of adventures in outer space, we look for other planets with similar natural resources in our speculation as to the presence of life. On the moon, for instance, to the best of our knowledge, only one natural resource is in existence—there is no air, no water, no soil—only minerals and rocks. Therefore, no life can exist as we know it. The earth is blessed with all these resources to a limited extent; therefore, plants and animals have had the opportunity to develop. How long they will last depends upon conservation of their use and wise management.

**The human resources:**

It is important for children to realize *they* are a part of the life on the earth, but different from lower forms; they are blessed with the power of making choices. By learning to make wise choices instead of following impulsive urges, each can guide the direction of his life and thus make valuable contributions to society and bring honor to himself. This can be of great importance in the guidance program.

**The guide:**

There are seven major divisions in the guide—the Inorganic Natural Resources: minerals, air, water, soil,* and the Organic Natural Resources: plant, animal, and human. After a general introduction to each of the resource areas, there are three subdivisions according to grade level—primary, intermediate and junior high. Each of the subdivisions includes specific scientific and social science concepts related to conservation followed by suggested discussions and experiments for demonstrating conservation problems. Each subdivision also includes a specific bibliography and there is a general bibliography at the end of the guide.

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*Soil must contain organic material, both living and dead, to be good soil, but since the basic material is inorganic, it has been classified as such.

This guide is not a textbook, not a new course of study. It is designed to assist with activities in elementary or general science, social studies, and English. It suggests only the most basic concepts in modern conservation practices. Some concepts, because of their importance, are repeated in two or more grade levels.

**Acrostic**

The order in which the natural resources are here presented divides them into Inorganic (those resources necessary to support life on the earth), and Organic (the life itself). An acrostic which might be used to assist children in remembering these is "Maw's Pah" (mother's father).

INORGANIC RESOURCES
M — Minerals
A — Air
W — Water
S — Soil

ORGANIC RESOURCES
P — Plants
A — Animals
H — Humans

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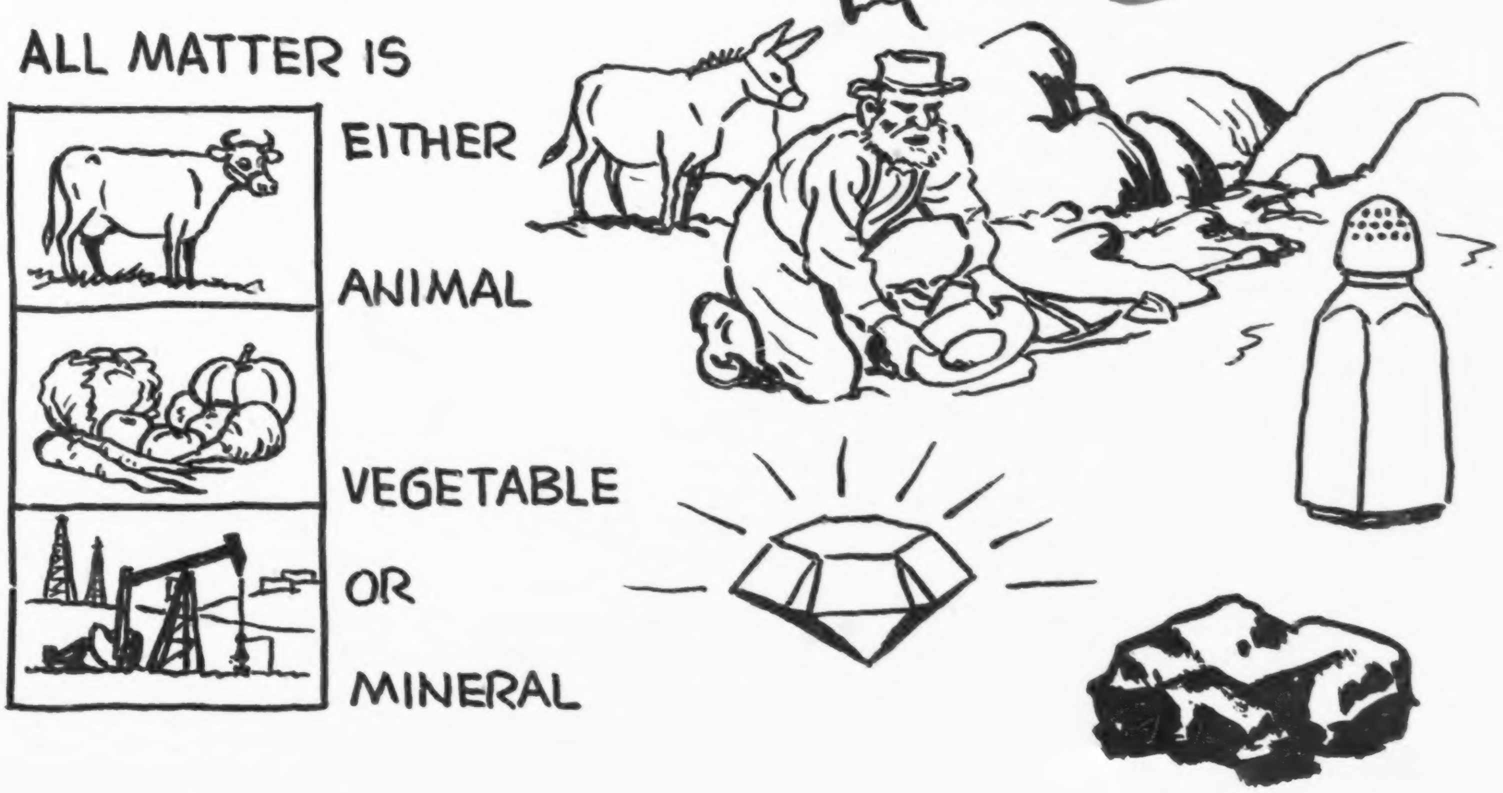
# Chapter 1

# MINERALS

## Primary Grades



## Introduction

From the time that the cry of "gold" brought settlers to search for their fortunes, the mineral industry has stimulated Colorado's growth and has remained a cornerstone of the state's economy. According to the publication, *Minerals of Colorado: A 100-Year Record,*... "from 1858 through 1957 Colorado's mines, quarries and wells produced more than $6 billion in new mineral wealth. Of this wealth about one-half was from metals, one-third from coal, petroleum and natural gas and one-sixth from construction materials and non-metallic mineral products." Of the $6 billion in mineral revenue, one billion came from gold, a half billion from silver and a half billion from molybdenum.

It is important for children to understand the nature and importance of minerals to the economy and to their own personal lives. The major minerals exist in fixed quantities and once taken from the earth cannot be replaced. It is obvious that mineral users must pay attention to conservation measures. They must regulate the extraction of the existing mineral supply, develop substitutes for the non-renewable minerals and utilize fully all reusable minerals.

Some minerals are renewable to the extent that animal, plant and air resources are renewable. Minerals such as nitrates and carbon compounds form in the air and soil as a result of organic decomposition of plants and animals. Organic minerals are necessary for plant growth and, because animals eat plants, for animal growth. Although the organic minerals are renewable, a deficiency will result in poor crops or disease.

One need only look at and touch the objects immediately about him to realize the need for a sufficient supply of minerals. Thus far, nature has provided for man's needs, but the diminishing supply of important minerals demands man's attention to the wise use of mineral resources.

**All matter is either animal, vegetable or mineral.**

ACTIVITIES

1. Through discussions and pictures, develop the three classifications of matter—animal, vegetable and mineral.
   a. Prepare a bulletin board using photographs or pictures which students have drawn to illustrate the three classifications of matter.
   b. Play animal, vegetable and mineral game. (Explain that by vegetable we mean something that grows in soil.) An object is named. Player must give its classification. If he misses, he is eliminated from game.
2. To illustrate where minerals are found, examine samples of Colorado ores with magnifying glass in order to identify the following minerals:
   a. Hematite—red iron ore
   b. Silver
   c. Gold
   d. Galena—lead
   e. Malachite—copper
   f. Coal.
3. Compare a piece of mineral ore with a carrot and a

cat. Discuss primary physical characteristics of each.

4. Pupils can participate not only by collecting minerals but by going to resource people for proper identification. The teacher is the educational leader who directs an inquiry, not the authority for identification. The proper answers here are "I would like to know" and "Let's see if we can find out."

**There are many different kinds of mineral-bearing rock.**

Activities

1. Exhibit specimen of granite and sandstone to demonstrate the following:
    a. Granite is composed of quartz, feldspar and mica. Cover a piece of granite with burlap and break it into small pieces with a hammer. Using a magnifying glass compare small pieces of granite with pieces of massive quartz, feldspar and mica to see that granite is made primarily of these three separate ingredients.
    b. Sandstone is composed of grains of sand cemented together. Demonstrate this by using a magnifying glass.
2. Take the class on a short walk to find variety of rocks.
    a. Sort specimens and arrange on black paper according to those rocks which look alike and those which are most abundant in the area.
    b. Provide plenty of time for the children to examine the specimens with a good magnifying glass. Observe mineral veins, changes in color, consistency, etc.
    c. Acquaint children with names of rocks: granite, sandstone, limestone, etc.
3. Provide a space for children to exhibit rocks they find, stressing variety rather than size or quantity.

Collecting, identifying and labeling rocks can be fun. The teacher need not be the authority on identification at all times, but rather he should be the educational director. At least one student in every class will know of a "rock hound" who will be glad to assist in identification.

4. Invite someone in the community who collects minerals to exhibit his collection. Note: The ethics of rock collecting provide that no one handles another person's collection without permission.

A magnifying glass is useful when identifying strange rocks. Different types of minerals may be collected during family excursions to the mountains and to old mine camps.

5. Have children begin simple rock collections of their own. On the back of a boxtop or a piece of shirt cardboard glue and label pieces of granite, sandstone, limestone, quartz, mica and feldspar.

**Soil is rock that has been crumbled or worn down and mixed with plant and animal matter.**

Activities

1. Crush soft rock to show that it can be crumbled to soil consistency. Try growing seeds in it. If seeds do not grow explain necessity of the presence of organic material.
2. Add fertilizer to poor soil. Show how plants will thrive in soil that has a combination of minerals and organic material.

**Some minerals are precious metals.**

Activities

1. Make a list and discuss use of precious metals.
2. Make a scrapbook showing how gold settles at bottom of pan.
3. Show pictures of gold and silver mines. Have children describe mine shafts they have seen or visited. Discuss dangers of abandoned mine shafts.
4. Compare a piece of lead with a gold or silver coin. Discuss reasons why gold and silver are considered more precious—durability, scarcity, shininess.

**Some minerals are gems.**

Activities

1. Show unpolished stone and then the same kind cut and polished. Compare gems with precious metals. Both are valuable and both are minerals.
2. Show examples of jewelry made from Colorado minerals.
3. Visit a mineral display at a college or museum. Observe variety of gems. Some gems are clear and colorless; some are clear, but colored; some glow in the dark. Discuss pigmentation, luminescence, crystallization, etc.

4. Compare a piece of coal with a diamond. Both are the same material.
5. Look at an agate collection (marbles). Observe rings, blemishes, hardness.

**Salt is a mineral.**

Activities

1. List uses and importance of salt.
2. Demonstrate crystallization by dissolving salt in boiling water. As water cools, suspend a thread from a stick across top of the container, and as water evaporates crystals will form on the thread. Another method is to pour salt solution over a clinker or hot piece of coal. Watch the number of crystals grow. Observe flat surfaces of salt crystals under a magnifying glass.
3. Learn how salt is mined or secured by evaporation.
4. Taste salted and unsalted peanuts. Discuss uses of salt in food seasoning.
5. Discuss necessity of salt in humans and animals.
   - a. Salt aids in movement of chemicals in body (through osmosis).
   - b. Animals crave salt instinctively, and are often found at salt licks or deposits.
   - c. Too much salt is dangerous to normal body functions (dehydration). Sea water can be fatal if taken in excess.
   - d. Discuss salt in ocean water—prospect of removing salt from ocean water. The expense is great, but the scientists are working towards reducing the cost of this project. Reference: Ransome, Arthur. *Childcraft, Vol. III,* Field Enterprises Corporation, Chicago, Illinois, 1961, pages 132-143.

**Coal, oil and gas are important minerals in everyday use.**

Activities

1. Have students list primary uses of each of the above minerals.
   - a. Coal—fuel for heating, for steam engines
   - b. Oil—fuel for heating, automobiles (gasoline), trains and trucks (diesel fuel), planes (kerosene); lubrication
   - c. Gas—fuel for heating.
2. Discuss methods of extraction—coal mining, oil and gas drilling.
3. Prepare a bulletin board illustrating uses of coal, oil and gas.

**Organic materials are replacing metals and other minerals in daily use.**

Activities

1. Bring plastic objects from home (toys, containers, etc.). Show how plastic helps to conserve metal resources.
2. Set table—one side with plastic, the other with metal.
3. Saran wrap and waxed paper can be used in place of other foil. Show both. Why is metal foil preferable in some situations (strength, durability).
4. Find out what oils do not originate from petroleum (vegetable oil, whale oil, linseed oil, cod liver oil).
5. Rubies and sapphires can be manufactured. Compare glass jewelry with mineral gems.
6. Compare concrete and true stone. Demonstrate how concrete is made. Mix a small amount of cement with sand and water. Pour in a slab and let children initial it.

**The world's supply of minerals cannot be renewed.**

Activities

1. Discuss how automobiles must continually be refilled with gasoline. What happens when an oil well runs dry? Can it be refilled?
2. Show pictures of abandoned mines. What happens to community when mines are abandoned? Where does new ore supply come from?
3. Show pictures of iron pits on the Mesabe Range where the richest deposits have been depleted. Increasingly high costs have made substitutions for iron necesary.

**Rocks are part of the scenery which we enjoy.**

Activities

1. Hike around your area to observe any rock formations. Note colors of rocks, consistency, weight.
2. Bring post cards, pictures, tourist folders, etc., from home to make a bulletin board display of mountains and rock formations. Provide time for class to discuss trips they have taken to rocky areas.
3. Show color slides of Colorado rock formations. Select photographs that show bright colors or have identifiable shapes. For example: Red Rocks, Castle Rock, Elephant Rock, Camel Rock, Ship Rock.
4. Using a paper plate, build a miniature mountain scene on it with rocks, clay, papier mache, colored paper, etc. Children may have horse or Indian models which would fit into their scenes.

**Minerals are essential to plant growth; good farming practices demand replenishment.**

Activities

1. See experiments under Soil in this guide.
2. Discuss methods used to replace minerals in the soil taken out by farm crops—crop rotation-using legumes, animal fertilizer and chemicals (liquid or dry).

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### Films and Filmstrips

(Films and filmstrips without sources listed will be found in the *Mountain Plain Film Library Association Joint Catalog* 62-64)

*Blow Wind Blow.* 11 min. b & w.

*Discovery of Oil.* Colorado Interstate Gas Co., Denver, Colo.

*How Rocks Are Formed.* $4.95. Jam Handy Co., Chicago, Ill.

*Origin of Our Earth.* Jam Handy Co., Chicago, Ill.

*Our Earth Is Changing.* Jam Handy Co., Chicago, Ill.

*Rocks and Minerals.* Illa Podendorf, Children's Press, Inc., Chicago, Ill. K-4.

*What the Forest Does.* Jam Handy Co., Chicago, Ill.

### Other Aids

The Carey Salt Company, Hutchinson, Kansas, has free material.

Color slides may be rented from R. Pickens, 610 North Martin Ave., Waukeegan, Ill. (50 slides—$3.50 per week.) Write for catalog.

Colorado Interstate Gas has excellent maps showing gas lines. Schools can obtain booklets on the natural gas industry.

Mineral displays in Colorado:

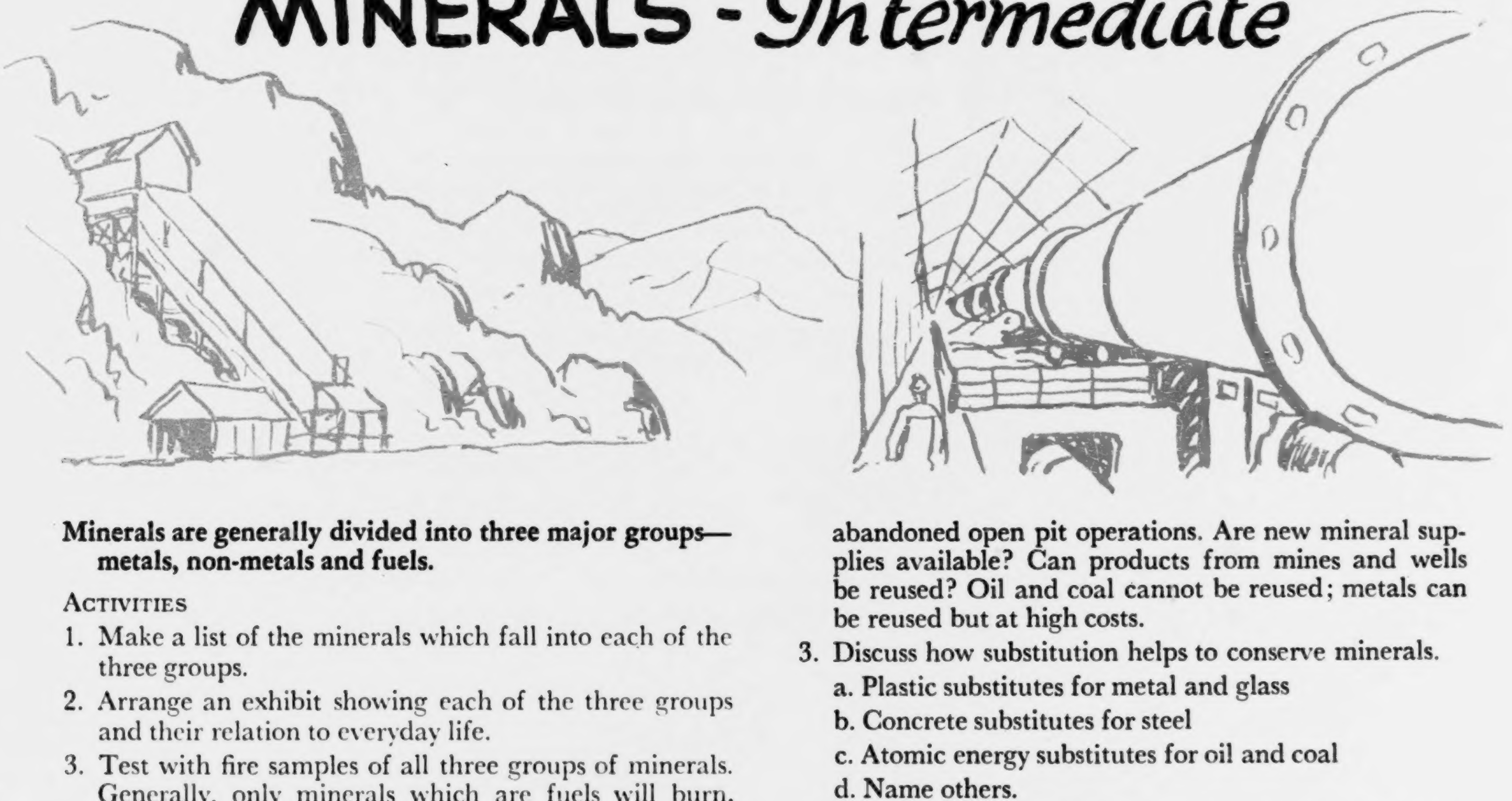
Boulder—Department of Geology, University of Colorado University Museum, Hale Building.

Colorado Springs—Colorado College Museum, Palmer Hall.

Denver—Colorado Museum of Natural History, City Park. Colorado State Bureau of Mines Exhibit, Colorado State Museum, 14th and Sherman.

Golden—Colorado School of Mines.

# MINERALS - *Intermediate*



**Minerals are generally divided into three major groups—metals, non-metals and fuels.**

ACTIVITIES

1. Make a list of the minerals which fall into each of the three groups.
2. Arrange an exhibit showing each of the three groups and their relation to everyday life.
3. Test with fire samples of all three groups of minerals. Generally, only minerals which are fuels will burn, except at very high temperatures.
4. Give a report describing the general characteristics of metals. Which metals are unusual? (Mercury exists in a liquid state; magnesium burns at low temperatures.)
5. Discuss uses of non-metals—rocks, Portland cement, gypsum, plastics, salts.

**Minerals are non-renewable resources which exist in fixed quantities.**

ACTIVITIES

1. List major non-renewable mineral resources—oil, gold, iron, uranium, etc. What mineral resources are renewable?
2. Show pictures of abandoned mines, capped oil holes, abandoned open pit operations. Are new mineral supplies available? Can products from mines and wells be reused? Oil and coal cannot be reused; metals can be reused but at high costs.
3. Discuss how substitution helps to conserve minerals.
   a. Plastic substitutes for metal and glass
   b. Concrete substitutes for steel
   c. Atomic energy substitutes for oil and coal
   d. Name others.
4. Give a report on the amount of coal, oil, iron, gold, etc., available and the rate of use. Estimate how long it will take to use up available resources.

**Some minerals may be used repeatedly.**

ACTIVITIES

1. Discuss how iron can be used repeatedly (remelted and used in steel alloys in which the iron content is ½ ore and ½ scrap iron).
2. Collect scrap iron from homes and sell to a scrap iron dealer. Use the money for a worthy class project. Discuss wartime collection programs.
3. Visit a scrap dealer and observe all metals that have repeated use—iron, copper, aluminum, zinc, tin, etc.

A rock collection can be made into a good reference library by displaying it as shown in the picture above. Classifying and labeling the minerals will provide a good learning situation for the students.

**Minerals are not evenly distributed within the earth's crust.**

Activities

1. Locate famous mines or large ore deposits on a Colorado map. (Gold—Cripple Creek; Silver—Leadville; Molybdenum — Climax; Uranium — Four Corners.) Why are there no significant metallic ore deposits in the plains areas?
2. Compare rocks containing samples of ore, such as feldspar, mica, and quartz. Ore veins are caused by uneven cooling of molten materials.
3. Use the *Colorado Yearbook* to show current mineral production. Does there appear to be a concentration of a particular mineral in a relatively large area of the state? What areas produce the most minerals? What mineral is mined in the largest quantity?
4. Prepare graphs and other statistical material showing mineral production in Colorado.
5. Write reports on geologic formation of ore deposits. Geologic maps are available from U. S. Geologic Survey, New Customs House, Denver.

**Large capital investment is necessary for the commercial extraction and processing of most minerals.**

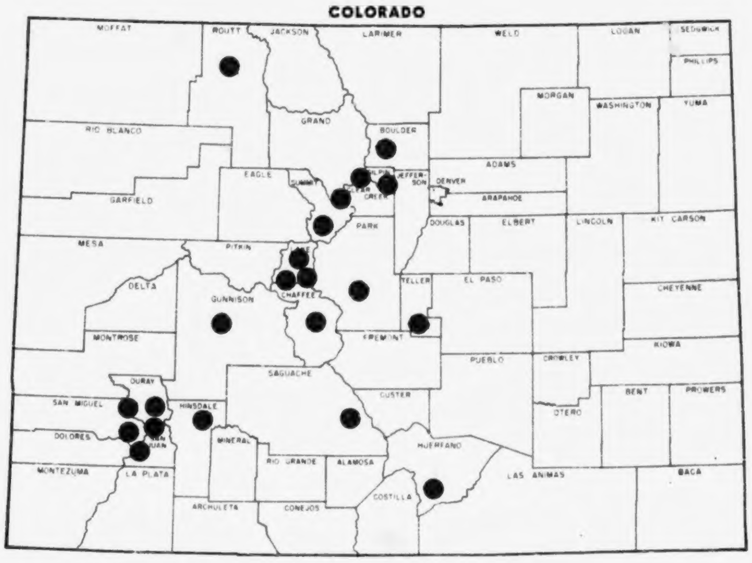
Activities

1. Discuss processes of mineral extraction—shaft and tunnel mining, open pit mining, panning, sluicing, hydraulic mining, shale distillation, pumping oil.
2. Discuss transportation methods and costs between place of extraction and place of processing.
3. Discuss costs of surveying and exploration. The American Petroleum Institute states that the oil industry spends approximately $200 million annually in the United States for geophysical exploration.

**Processing minerals usually requires considerable use of water and often creates waste disposal problems—a conservation problem of pollution.**

Activities

1. Demonstration of water use and material waste in gold panning.
   a. Fill pan or pie plate with dirt and gravel.
   b. Wash with enough water to allow heavier materials to sink to bottom. (To demonstrate settling in more detail put sand, dirt and gravel in a glass jar, shake and observe how heavier materials sink to bottom.)
   c. Keep a chart of how much water is used for each panning. Consider how much water would be needed for a large scale panning operation (placer mining).
   d. Instead of throwing away waste from panning, keep all of it, including the water, in a bucket. What would happen to the sink if the waste were poured in there? What happens to a stream when mining wastes are poured in?
   e. Show pictures of areas where mining wastes have been harmful—mine tailings on Clear Creek in the Idaho Springs area, dredge piles near Fairplay and Breckenridge.
2. Explain use of settling ponds and how these present problems in water pollution, dust erosion, destruction of large areas from sediment deposits.
3. Discuss methods of preventing mining wastes and pollution—utilization of all mining by-products, building of sediment basins.
4. Discuss how the discovery and production of gold in Colorado influenced the early history of the state.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ALAMOSA
LAS ANIMAS
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COSTILLA
ARCHULETA
CONEJOS

The dots on the map above show where major gold discoveries have occurred in Colorado. Note that the marked gold mining areas are centered along the Continental Divide, with another area in Southwestern Colorado.

**Minerals formerly of little value are now in demand as sources of atomic energy.**

Activities

1. Discuss why uranium is the chief source of atomic power. Uranium is the most radioactive material available. Radioactivity is an indication of molecular instability.
2. Discuss Colorado's contribution to the uranium production of the country and of the world.
3. Uranium production affects population concentration. Compare gold booms of the 19th century with the recent uranium boom in the Four Corners area.

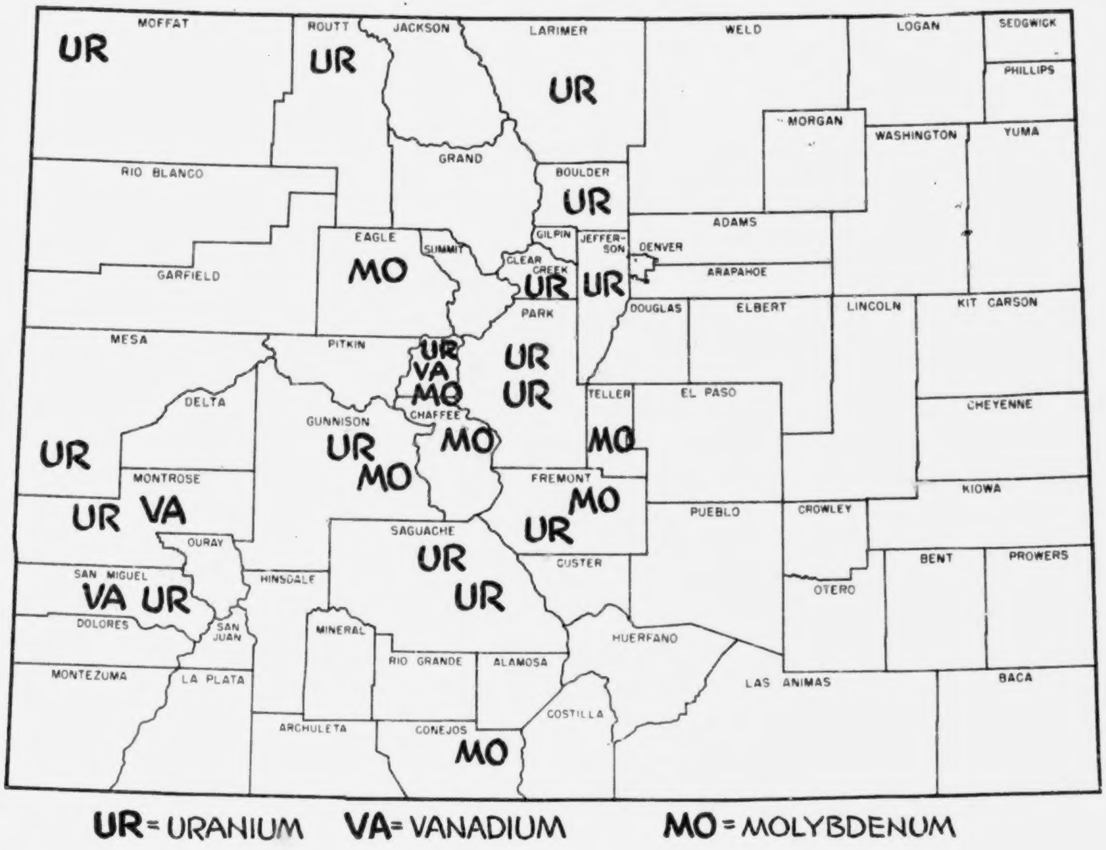
## 6—MINERALS/INTERMEDIATE

**Oil, one of Colorado's most important minerals, provides fuel and energy for transportation and industry.**

ACTIVITIES

1. Locate Colorado's primary oil producing regions on a state map. Information is available from Colorado Bureau of Mines.
2. Discuss the role that Colorado plays in oil shale production. The world's greatest known supply of oil shale is located in Western Colorado. What is the current status of the Rifle refinery? What is the future of oil shale production?
3. Visit a filling station and make a survey of all petroleum products used in servicing an automobile.

**Mining of molybdenum has been a major factor in the economic growth of Colorado. More than 542 million dollars' worth of this mineral was produced from 1918 to 1958, most of it from a large mine at Climax, Colorado. The molybdenum deposit at Climax is believed to be one of the largest in the world.**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ARCHULETA
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COSTILLA
MO
UR= URANIUM
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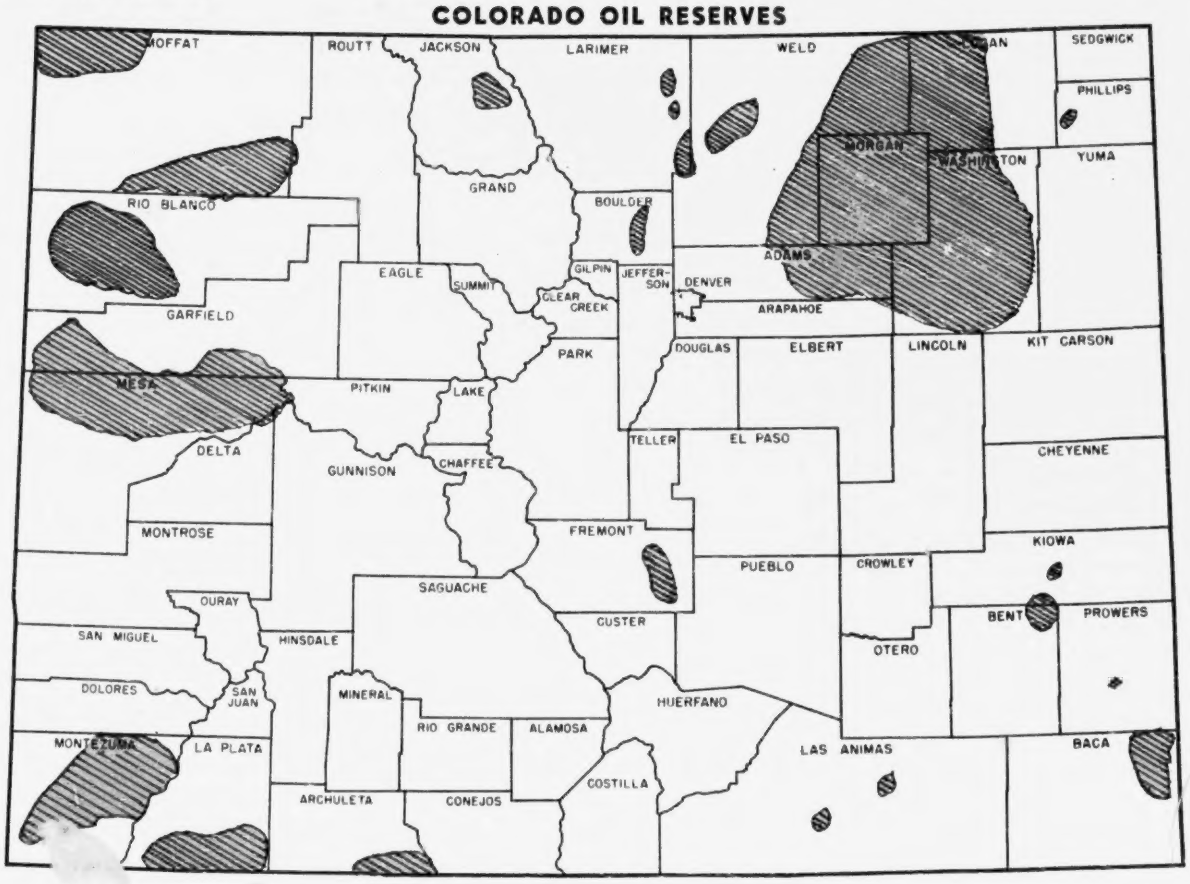
MO = MOLYBDENUM

**The shaded portions shown below on the map of Colorado indicate major oil producing areas.**

**COLORADO OIL RESERVES**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COSTILLA

4. Visit an oil refinery to study methods used in producing finished products from crude oil.
5. Discuss common oils which are not classed as minerals —animal fats, vegetable oil. Are any non-mineral oils used for fuel?

**Natural gas is an important fuel for heating homes and use in industry—a non-renewable resource.**

Activities

1. Compare natural gas and crude oil. Natural gas is similar in chemical composition to oil; gas is vaporized, oil is liquid.
2. Compare use of natural gas with other fuels—coal, oil, electricity. Urban areas are using gas increasingly because it is a cheaper fuel than coal or oil.
3. What is the main source of natural gas for your community?
4. On a United States map trace the major natural gas pipelines. Do the same thing on a Colorado map. For information, inquire at local gas company.
5. On a cutaway drawing of an oil well show the relationship between oil deposits and natural gas deposits. Show how gas can be used to force oil toward the surface. (Gas from the top of dome forces oil out of side of dome up the well casing.)
6. Discuss the dangers of misuse of natural gas—asphyxiation, explosion.

**Modern nations require tremendous quantities of fuel in order to carry out their domestic and foreign policies.**

Activities

1. Prepare a table display showing uses of mineral fuels.
2. Collect newspaper articles on uses of atomic energy.
3. Discuss how mineral energy is used for powering submarines, rockets, power plants, automobiles, etc.
4. Make a picture chart showing the type and uses of power throughout history. Show how ancient practices have been replaced by more economical methods.

ATTENTION!
USE NONRENEWABLE
MINERALS WISELY
ELEMENTS
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AL
ELEMENTS
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FE

Exhibits like this help children learn the wise use of non-renewable minerals. This exhibit was used in Franklin School at Fort Collins, Colorado.

5. Discuss how much fuel is necessary to manufacture, maintain and power a farm tractor, an overseas freighter and a tank. Colorado has a tremendous supply of coal. It is mostly of a soft variety—but is a valuable reserve for the state.

**No modern industrial nation has an adequate supply of all mineral resources within its own boundaries.**

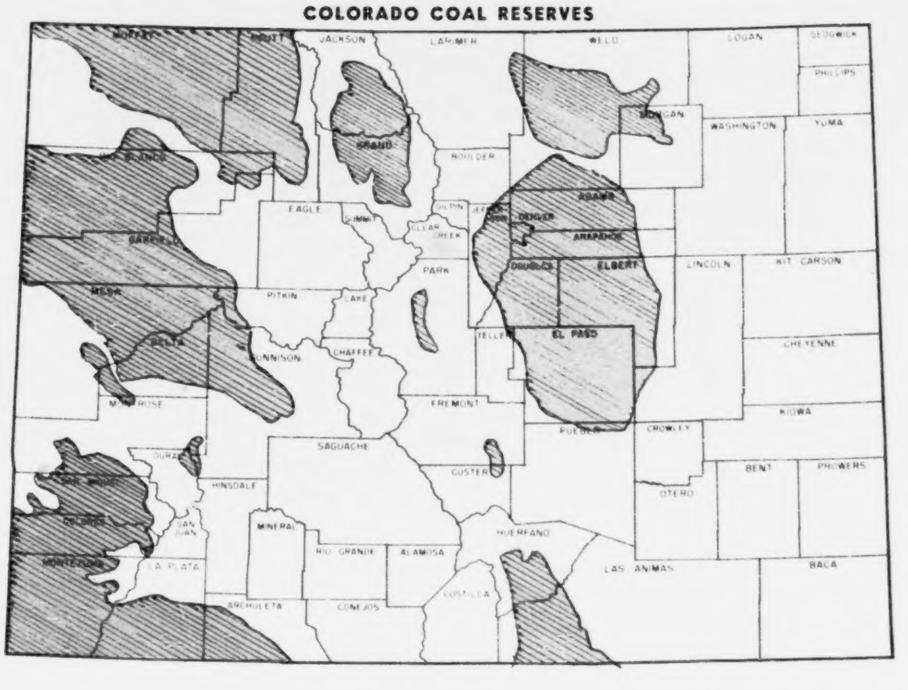
Activities

1. Locate world's largest deposits of minerals. Are all mineral supplies presently being used? Has there been an appreciable depletion of mineral resources within the last ten or twenty years?
2. List the leading manufacturing nations and find their sources of minerals. Which nations have the smallest amount of resources? (Britain, Japan)
3. Which important minerals are not abundant in the United States and where can these minerals be obtained? Tin is supplied by Central and South America; nickel comes from Canada.

Shaded areas on the map (right) show where coal reserves are located in Colorado. Production of coal in Colorado is down to about $24 million a year. Practically all of the coal deposits in Colorado are soft coal.

The six major coal regions in Colorado are the Green River Basin (Moffat, Routt and northeastern Rio Blanco Counties); Unita Region (Gunnison, Pitkin, Delta, Garfield, Rio Blanco and Mesa Counties); San Juan River Region (this is located in the extreme southwestern part of Colorado and extends southward into New Mexico); North Park Field (Jackson and Grand Counties); Denver Region (this extends from Weld County south to El Paso County in east central Colorado); and the Trinidad Field (Las Animas and Huerfano Counties). The Denver Region covers 7,600 square miles and contains an estimated 14 billion tons of coal, with most of this deposit in the lower 200 feet of the Larimer formation.

COLORADO COAL RESERVES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ARCHULETA
CONEJOS
COSTILLA

4. Discuss the fact that until recently land conquests provided a new source of minerals. Will outer space provide a new source of supply? How long will the earth's major supply of minerals last, considering that the United States alone used more minerals from 1900 to 1960 than were used in the entire history of the world by all nations?
5. Discuss how nations have solved their mineral supply problem through substitution of minerals on hand, reciprocal agreements with other nations, and war.
6. Make a comprehensive list of the important minerals the United States does and does not have. Find out what agreements the U. S. has with other nations concerning minerals.

**Mineral conservation includes all means by which mineral supplies can be made to serve more people for a longer time.**

Activities

1. Discuss methods of reclaiming minerals—re-refining oil, collection of scrap metal into dumps.
2. Discuss the use of alloys in making more durable, longer-lasting materials. Iron + Hardeners = Steel; Aluminum + Magnesium = Strong Alloy.
3. Discuss regulation of use as a method of conservation.
   a. Regulations limit oil production per well, rate of flow and number of wells that may be drilled in a field.
   b. The United States Government is the sole buyer of uranium extracted in this country and restricts the amount it buys to its needs.
4. Prepare radio scripts, dramatic skits and round-table discussions relating to problems of mineral conservation.

**Valuable minerals are reclaimed from industrial wastes.**

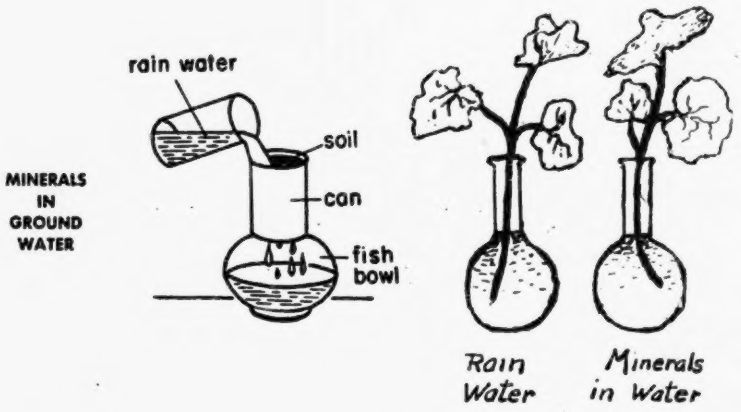
Activities

1. Discuss uses of carbon trapped through smoke control in factories—carbon paper, "lead" pencils, water filtration systems.
2. Review uses of coal tar derivatives. Information is available from National Coal Association, 1130 17th St., N.W., Washington 6, D. C.
3. List key products derived from oil—detergents, synthetic rubber, synthetic fibers and plastics. For detailed information see the booklet *Facts About Oil.*

**Scenic rock formations are often preserved in parks for information and beauty.**

Activities

1. Prepare scrapbooks on the national parks and monuments in Colorado. Which ones have the most interesting rock formations.
2. Discuss how Congress has helped each state to preserve historical and scenic beauty by law.
3. Show pictures of rocks that have striking colors and shapes—Red Rocks, Castle Rock, Ship Rock, Elephant Rock, "Kissing Camels," etc.



**Minerals are necessary to good plant growth.**

Activities

1. Compare growth of plants in distilled or rain water versus water poured through a can of rich soil. Put in equal glass jars. Place geranium slips (same size) in jars and observe comparative growth.
2. What fertilizers are used in your community? Liquid chemical (nitrates)? Dry chemicals (lime, nitrates)? Animal fertilizers?
3. 4-H Club boys will explain crop rotation, use of legumes, nitrogen fixing bacteria, and returning chemicals to the soil.
4. Discuss minerals in man's food, how it comes from the soil, etc.
5. Many of the so-called "worn out" farms of the Eastern Seaboard are examples of failure to replenish the minerals in the soil.

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### Films and Filmstrips

(Films and filmstrips without sources listed will be found in the *Mountain Plain Film Library Association Joint Catalog* 62-64)

*Distribution of Heat Energy.* 11 min.

*Fuels and Heat.* 11 min.

### Other Aids

Colored slides on rocks and minerals are available from R. Pickens, 610 N. Martin Ave., Waukeegan, Ill.

# MINERALS - *Junior High*

**Minerals are generally divided into three groups: metals, non-metals, and fuels.**

Activities

1. Collection of minerals.
   a. Collect sample pieces of metals such as iron, copper, aluminum, zinc, lead, chromium-plated material, nickel-plated material, gold and silver jewelry, silverware or coins.
   b. Collect coal, a bottle of some liquid fuel (kerosene, fuel oil or other petroleum derivatives). Use natural gas from outlets in room.
   c. Examine the collected materials. Decide how to separate them into their proper categories.
2. Classification of minerals on the basis of physical characteristics.
   a. Compare outward appearance.
   b. Scratch each specimen with a nail file.
   c. Strike specimens with a hammer or bend them.
   d. Expose them to flame.
   e. Feel their surfaces.
   f. Compare lustre (metals have shiny lustre).
   g. Which are malleable (lend themselves to shaping)?
   h. Which ones break up into granular or dust material?
   i. Which ones burn?
3. Have an expert on rocks and minerals speak to group on what characterizes each division of minerals.

**Minerals are non-renewable resources existing in fixed quantities.**

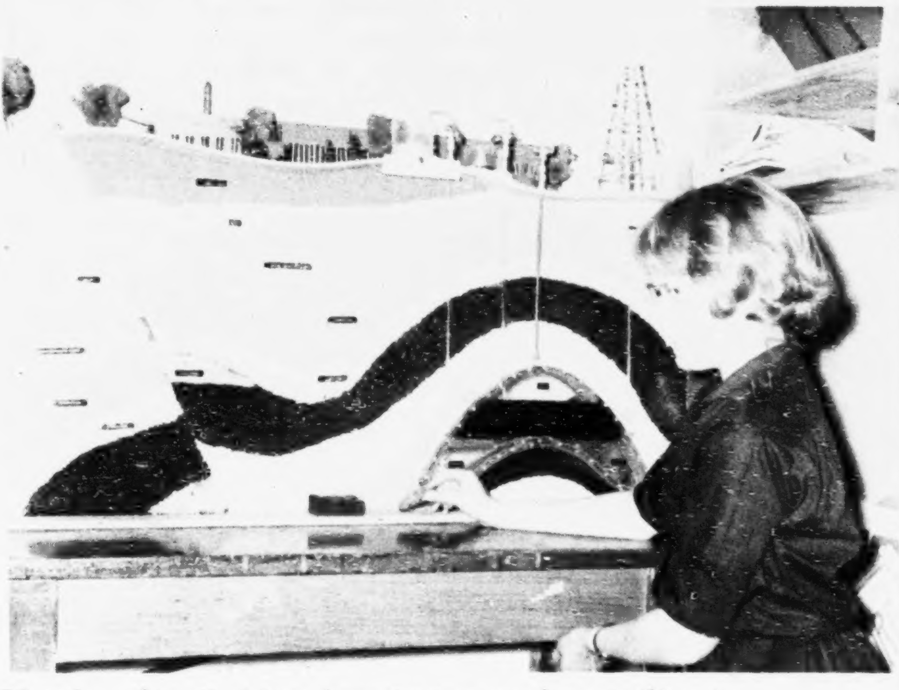
Activities

1. List the following on the board: corn, marble, lumber, wildlife, wheat, iron, copper, chromium, oil, gas, silver, coal, gold, cotton, tin, zinc, nickel, salt, sulphur, fruit, limestone, gravel, shale, granite, uranium and sandstone. From this list select those that can be grown, then those that come from organisms once alive. The remaining ones are those in fixed quantity and non-renewable. In discussing each product keep in mind its origin.
2. Study a chart or listing of the mineral composition of the earth's crust from a chemistry book. Note the percentages of each mineral.

**The location of minerals is directly related to geologic processes.**

Activities

1. Secure map of Colorado mineral locations and a map of the geology of Colorado. Compare to show relationship between mineral locations and geologic processes.
2. Use chart (see references) showing the formations of the Denver-Foothills region to show how water-soluble minerals are deposited in their present locations.
3. Explain mountain-making and wearing away. Associate this with the location of ore-bearing rocks, sedimentary ore deposits, etc.
4. Collect specimens of the following minerals in natural form: gold, silver, copper, nickel, iron, aluminum, magnesium, lead, zinc, molybdenum, vanadium, uranium, beryllium, zincronium. Divide these into three groups: those that exist in pure form; those that exist both in pure and compound form; those that exist solely as compounds (ores).
5. Discuss the sea as an untapped storehouse of minerals.



Oil and gas formation in a dome structure are shown in this cutaway diagram made by the Junior Conservation Club at the Fort Morgan, Colorado, Junior High.

**An abundance of mineral resources is essential to supply modern industrial nations with necessary materials and energy.**

ACTIVITIES

1. Prepare a bulletin board illustrating kinds of energy used in the history of man.
2. Discuss changes in fuel use in the last sixty years. compare coal, oil and gas needs of 50 years ago with present needs.
3. Find out how much uranium is needed to provide energy for atomic power plants.
4. List the kinds of minerals necessary for human growth and development.
5. Discuss trade agreements as a means of obtaining necessary minerals such as iron. How can highly industrialized but mineral-poor countries such as Britain and Japan maintain their output? Discuss nations which have used conquest of other lands (war, colonization) as a means of obtaining minerals.

**The United States has used more minerals in the last sixty years than were used by all countries in the entire history of man prior to 1900.**

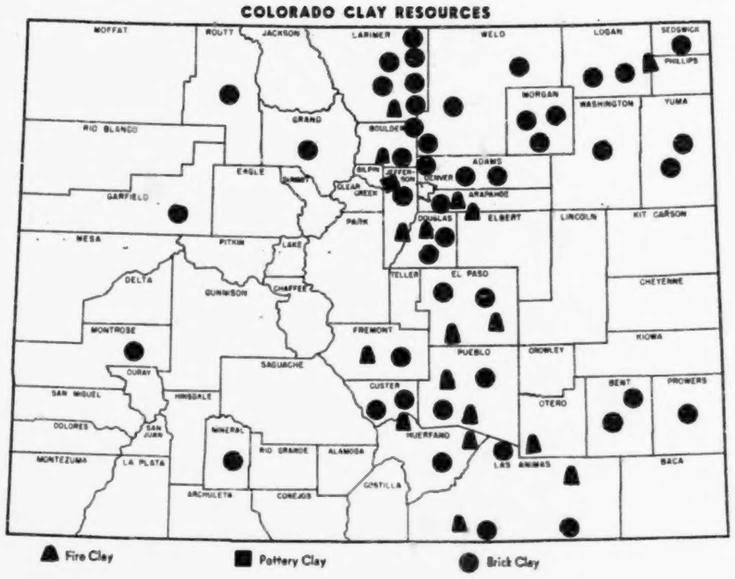
ACTIVITIES

1. Compare U. S. population in 1900 and 1960 and projected population figures for 2000. How will current mineral consumption be affected by the population increase? Are mineral supplies unlimited?
2. Show pictures of abandoned Colorado mines to illustrate that the most easily obtained mineral sources are used first. Location and development of remaining supplies often prove more expensive than extracting the original discoveries.
3. Discuss increase in use of iron and steel products and changes in types of ores being used in the last 60 years.
4. Discuss the effect of the automobile on the petroleum industry.
5. Compare mineral use in the United States with that of other countries. (The United States uses approximately half of all the minerals used by the entire world. If the United States' rate were world-wide, mineral use would increase eight times.)

**Minerals influence the location and production of industry as well as world trade, foreign policy and international relations.**

ACTIVITIES

1. On a map of the U. S. showing major highway systems and cities, mark the places where our principal mineral industries are located. Compare this with a geologic map of the U. S. and discuss relationships involved.
2. Locate and discuss the industries in Colorado that are near or on mineral deposits. Locate industries that are dependent on distant sources of minerals and try to determine what is strategic in their location.
3. Visit a manufacturing plant of any kind and note the minerals used in the production of the finished product. What is the importance of minerals to the manufacturer? Can you think of any product in which no minerals are used in processing?


COLORADO CLAY RESOURCES
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LA PLATA
RIO GRANDE
ALAMOSA
LAS ANIMAS
BACA
ARCHULETA
CONEJOS
COSTILLA
Fire Clay
Pottery Clay
Brick Clay

**The map above shows the location of various types of clay in Colorado.**

4. Find out what major international trade agreements on minerals the U. S. has. How else does the U. S. obtain needed minerals. (Private industries own companies in mineral-producing countries.)
5. Discuss the necessity of waging war for oil. Where did Germany get its petroleum in World War II? Where does Russia get its oil? Discuss American oil interests in foreign countries.

**Energy sources change with technological development.**

ACTIVITIES

1. Compare the kinds of energy used by an industrialized society and a non-mechanized culture.
2. Trace through history the kinds of energy used by man.
3. Discuss the Industrial Revolution as bringing about a need for new sources of energy for transportation and power. Discuss the steam engine, the steam boat, the automobile, the airplane and rockets.
4. Ignite a piece of paper using a magnifying glass and the sun as the source of heat and energy. How is solar energy being used today? (photosynthesis, industrial uses)
5. Discuss dangers from atomic "waste."
    a. Study information concerning atomic fallout. How will recent Russian and American tests affect the radiation level?
    b. Try to determine the effects of dumping radioactive wastes in rivers and the ocean. Where can radioactive wastes be disposed of?

**Colorado is an important producer of oil.**

ACTIVITIES

1. Locate on a state map the major oil producing areas.
2. Visit an oil refinery to study the methods used in producing finished products from crude oil.
3. Make a collection of products made from oil. Begin

with crude oil and continue to finished products, including products which are petroleum derivatives. The four main "secondary petroleum products" are detergents, synthetic rubber, synthetic fibers, and plastics.

4. Discuss the nature and importance of oil shale.
   a. Describe physical characteristics of oil shale. It is similar in appearance to limestone and is glossy.
   b. Heat a piece of oil-bearing shale in a kiln until oil is released or "sweats out." Required temperature is 1500-2000 degrees centigrade.
   c. Discuss cost of extracting oil from shale. Current cost is approximately one dollar per gallon. It is difficult to reduce cost because of heat expenses.
   d. What effect will oil shale operations have on surface area? Soil, plants and wildlife may be completely devastated with few possibilities of rejuvenation.

**Natural gas and coal are important fuels.**

ACTIVITIES

1. Compare characteristics of crude oil, coal and natural gas. All are similar in chemical composition; oil is liquid, gas is vaporized, and coal is solid.
2. Make a graph of increase in natural gas use in the last 50 years. (Contact local gas company.) How do costs of gas compare with costs of coal and oil?
3. What is the source of gas for your community? Local well? Pipeline?
4. Find out the amount of coal mined in Colorado in the last ten years.
5. Locate on a state map the most highly productive coal mines in the state. What coal mines are in your area?
6. Compare hard and soft coal for amount of heat, waste and smoke.

**Aluminum is one of the most plentiful of metals. Common clay has a great deal of aluminum. The electrical process of extraction has made it expensive.**

ACTIVITIES

1. Look up extraction process.
2. Locate main bauxite mines.
3. Why are aluminum-processing plants near great power supplies?

**Cement is a valuable building material used in making concrete.**

ACTIVITIES

1. Try building molds. Mix a small amount of concrete and pour into mold. Learn proportions from local builders.
2. Main supply in Colorado is at Florence.
3. Discuss scarcity of sand and gravel near cities.
4. Look up information about using prestressed concrete beams for buildings and bridges.

**Mining has had a great effect on Colorado history.**

ACTIVITIES

1. Trace the development and decline of Colorado towns as a result of gold and silver mining. Study some of the famous Colorado ghost towns.
2. Study present economic problems of mining areas such as Climax, Crested Butte, and Western Slope uranium areas.
3. Determine effects of uranium and vanadium mining on the state's economy during the past few years. Contact Colorado Bureau of Mines for latest information.

**The more abundant minerals can replace scarce and expensive materials.**

ACTIVITIES

1. List some abundant metals which replace scarce metals —aluminum for copper, rhodium for chromium plating, magnesium and aluminum alloy for steel.
2. Discuss use of alloys as a means of conserving metals. Alloys provide a stronger, more durable substance which does not have to be replaced as often as unalloyed metals. List some of the common alloys— iron + vanadium, tungsten = steel; copper + zinc = brass; copper + tin = bronze; magnesium + aluminum = "airplane metal" to replace steel; various alloys make up coins.
3. Discuss the importance of plastic as a replacement material.
   a. Plastic replaces metal in building materials.
   b. Plastic replaces glass bottles and metal in cans (polyethylene squeeze bottles).
   c. Plastic replaces glass and metal in eating utensils.
   d. Make a list of all things in sight that are made of plastic. Could metal be used instead of plastic?
4. Prepare a chart showing important synthetic materials and products which are petroleum derivatives.
   a. Synthetic rubber.
   b. Synthetic fibers — acetate, nylon, "Orlon," "Dacron," "Dynel," "Acrilan," "Fiberglas."
   c. Plastics.
   d. Detergents.
   e. Petrochemicals—ethylene, propylene, butylene, isobutylene, cyclohexane, phenol, etc.

**Processing minerals requires considerable use of water and often creates waste disposal problems.**

ACTIVITIES

1. To demonstrate how mining leaves wastes behind extract nuts from shells; also separate iron pyrite from granite, or quartz from pegmatite. Can wastes be used? Is there any cheap method of disposal?
2. Try to grow plants on mine tailings with and without fertilizer. Leach the tailings which have fertilizer applied to them and observe results.
3. Consult Colorado Game, Fish and Parks Department regarding fish survival in streams and lakes polluted by mine tailings and other mining wastes. Fish die because of cyanide or from mine tailings which cause clogged gills.
4. Consult Forest Service on the effects of mining debris on water conservation and spring runoff.

5. Discuss why water is needed in such large quantities in ore processing and what effects processing has on the quality of water.

**The use of mineral supplies can be extended by intelligent planning and attention to conservation practices.**

ACTIVITIES

1. Discuss the following as means of extending natural resources:
   a. Finding new or using deeper or more remote deposits.
   b. Increasing efficiency of manufacture in producing finished products.
   c. Guarding against artificial obsolescence of mineral products.
   d. Promoting research to increase the availability of minerals and the efficiency of their use.
   e. Placing restrictions on the development and use of minerals.
   f. Avoiding wars and armament races.
2. Show charts from a seismograph, explaining how new sources of petroleum can be detected. Discuss the importance of exploration in finding new mineral sources.
3. Explain depletion allowances as incentives to mineral exploration. A 27.5 percent depletion allowance provides that a company does not have to pay taxes on that percent of the total value of the operation per year.

**Wise use of minerals will conserve them for future use.**

ACTIVITIES

1. Discuss the following methods for conserving mineral resources:
   a. Mining and processing methods that result in least waste.
   b. Using renewable or plentiful substitutes for scarce or limited minerals.
   c. Salvaging and reusing mineral products when possible.
   d. Conserving products made from minerals by
      (1) Protecting against wear and corrosion.
      (2) Using products as long as possible.
2. Collect newspaper articles concerning federal regulations on minerals. Some of these regulations concern:
   a. Over-production and depletion of oil and gas.
   b. Production and sale of uranium.
   c. Stockpiling of strategic materials.
3. Discuss the necessity of state and federal regulations on minerals.
   a. Desire for private financial gain may result in wasteful exploitation of mineral resources.
   b. Mineral deposits frequently cut across property lines.
   c. Mineral extraction and processing sometimes damage other resources.

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*Barrel Number One*. Colorado Petroleum Council, 450 Petroleum Club Building, Denver, Colorado 80202.

*Blow Wind Blow*: 11 minutes. b & w.

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- Boulder—Department of Geology, University of Colorado
  - University Museum, Hale Building
- Colorado Springs—Colorado College Museum, Palmer Hall
- Denver—Colorado Museum of Natural History, City Park
  - Colorado State Bureau of Mines Exhibit, Colorado State Museum, 14th and Sherman
- Golden—Colorado School of Mines.

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## Vocabulary

alloy
anthracite
atom
bituminous
blast furnace

cadmium
carbon
chemist
coal tar
coke

collier
concentrate
condense
conveyor belt
dredge

dynamo
earth's crust
electron
electrostatic
element

export
fault
ferrous metals
fiberglas
fission

fluorescence
fossil
fumarole
fuse
fusion

gasification
geochemistry
geologist
gilsonite
graphite

hematite
hydraulic mining
hydrocarbon
hydrogenate
import

insulation
lignite
limonite
magnetite
magnetometer

matter
metal
metallurgical
metric ton
mineral

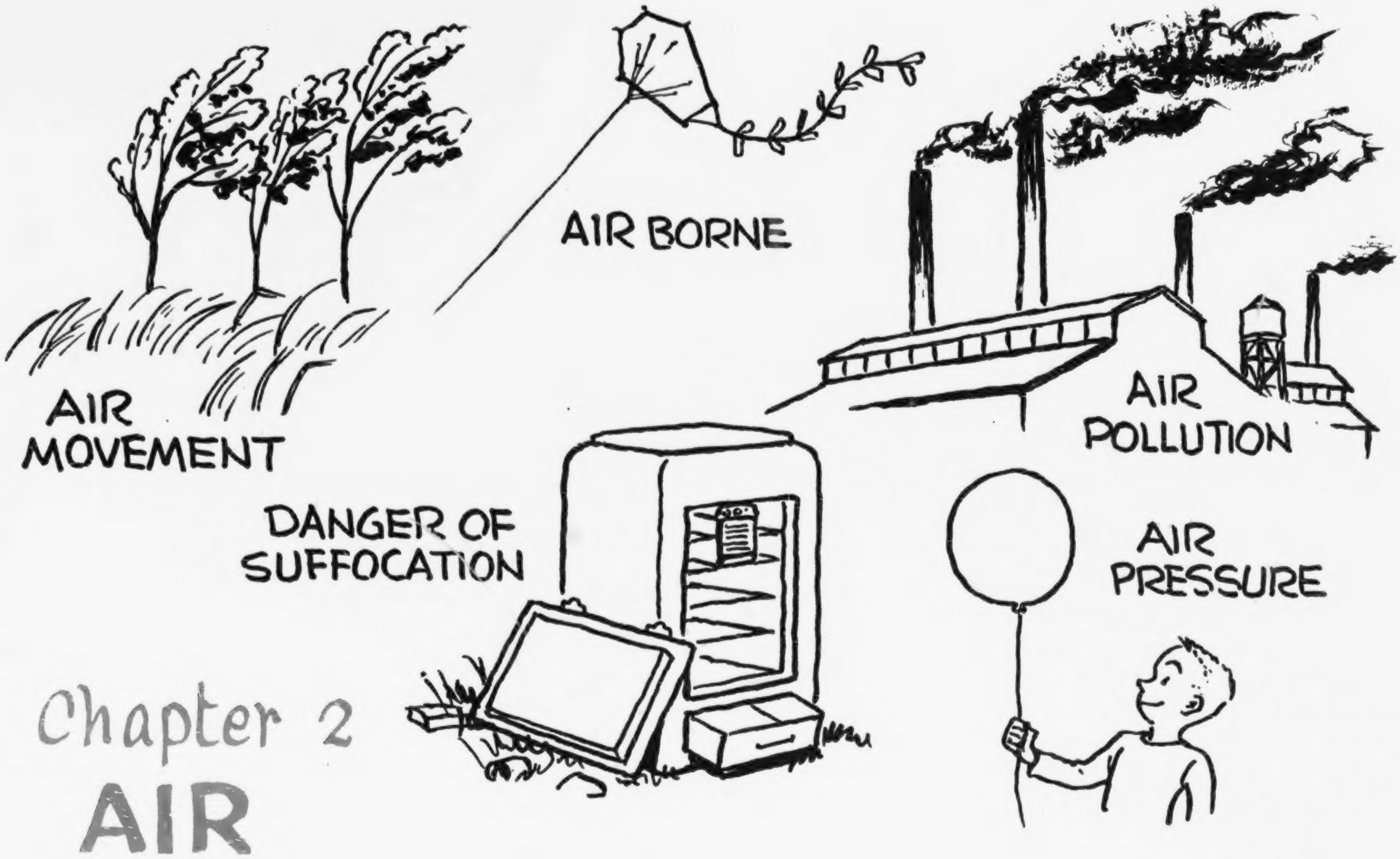
mineralogist
molybdenum
natural gas
nodule
nonmetal

non-renewable
oceanography
ore
paleontology
paleozoic era

reagent
refinery
renewable resources
robot
seismograph

shale
slag
stratum
sulphur
synthetic

turbine
vein
ventilation



## Chapter 2

# AIR

## -Primary Grades

### Introduction

The exploration of outer space illustrates dramatically that air is not a resource which merely exists and cannot be used wisely and conserved. When man leaves the earth's atmosphere he leaves his natural environment, but the conditions of the natural environment must be maintained if he is to survive in outer space. For this reason space scientists are continually studying the properties and characteristics of air in order to ensure man's survival wherever he goes.

Understanding the nature of air and using it wisely are no less important on earth than they are in space. It doesn't take long to understand that some areas have air which is dangerous to breathe. Industrial and domestic air pollution have covered large cities with smog and smaze and have increased the incidence of respiratory diseases significantly.

Even pure air will be useless, however, if it can't reach the lungs. Cellophane, plastic bags and discarded iceboxes and refrigerators cause many children to suffocate each year. Automobile deaths resulting from carbon monoxide poisoning could be prevented by maintaining a pure air supply.

Drowning is a form of suffocation which confronts all persons. Nonswimmers, are, of course, in greatest danger and should not enter the water without a life preserver, but even good swimmers can drown if all safety rules are not observed.

Understanding the air resource is extremely necessary for survival. People who know why breathing is important will know why it is important to practice all safety procedures necessary to maintain a continuous, pure air supply.

**Although we cannot see the air around us it has many physical properties.**

ACTIVITIES

1. Have children blow on hands to demonstrate that air can be felt. Discuss the power of wind.
2. Go outdoors and have children run and feel the air against their faces and hair.
3. Go outside and see how many things the children can observe that the wind is moving—clothes, leaves, flag, etc.
4. Make kites and pin wheels.
5. Discuss "good" and "bad" air. Bad air causes sleepiness and can cause suffocation as a result of a lack of oxygen. Always have a supply of fresh air. The more people in a room, the more air is needed.

**Air is essential to plant and animal life.**

ACTIVITIES

1. Seal a large growing plant with flowers on it in a jar. (Fill jar with plant in order to use up oxygen.) Ob-

serve how long it takes for flower and plant to wither and die.

2. Discuss breathing. Animals breathe oxygen from the air; fish are adapted to inhaling oxygen from the water. Both expel carbon dioxide. Plants absorb carbon dioxide from the air and expel oxygen.

**Cutting off man's air supply will cause him to suffocate.**

ACTIVITIES

1. Discuss all causes of suffocation — drowning, cellophane, abandoned refrigerators, other enclosures. Emphasize the danger of playing with anything which could block air supply. Putting cellophane over one's mouth or head is just like closing oneself in a jar.
2. Draw pictures of a skindiver with oxygen tanks to show how people can prevent suffocation. Draw pictures of refrigerators *with the doors off*.

**Automobile fumes, smoke from ashpits, industrial wastes and dust particles can make air harmful to breathe.**

ACTIVITIES

1. Have students tell about being near a burning ashpit or a busy downtown street. What was the effect on them?
2. Discuss diseases caused by air pollution—common cold and other communicable diseases.
3. Discuss human filter system (moist hairs and membranes in nose catch dust particles and other pollutants). Sneezing expels excess of particles. Emphasize importance of breathing through nose.

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# AIR - Intermediate

**Air is composed of a combination of gases and has recognizable physical properties.**

ACTIVITIES

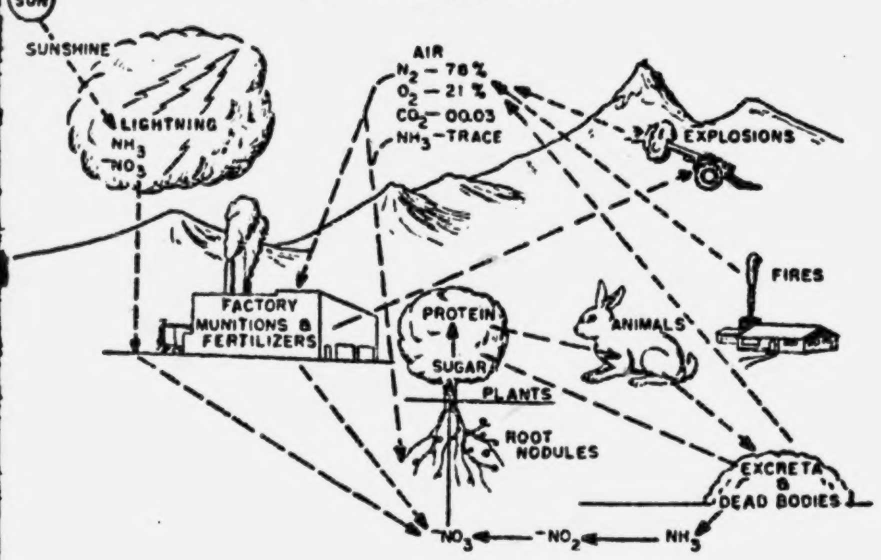
1. Construct graphs showing composition of air—oxygen, nitrogen, carbon dioxide, inert gases, moisture.
2. Demonstrate the movement of air by the use of an atomizer. Release a minute amount of vapor (perfume) from one corner of the room and have children raise their hands as scent reaches them.
3. Fly paper airplanes or paper plates to demonstrate elementary theories of aerodynamics.

**Humans, plants and animals depend on air for life.**

ACTIVITIES

1. Demonstrate interdependence of plants and animals by discussing the oxygen-carbon dioxide cycle.
2. Using ammonium nitrate, show effect of nitrogen on plants by fertilizing one small area in a planter.
3. Discuss nitrogen fixing bacteria from air on roots of legumes. Lightning frees nitrogen which combines with rain helping in fertilization.
4. Where possible an excursion to timberline area should be made and scarcity or absence of growth noted and discussed. Severe climatic conditions will not support tree growth; some shrubbery, mosses, and low growing plants only can adapt themselves to this climate.
5. Draw pictures illustrating how man uses air for transportation—planes, balloons, sailboats, hydrofoils, etc.
6. Show how plants depend on the air to scatter their seeds and ensure survival of the species. In season, bring in dandelion "puffs," "cotton" from cottonwood trees, maple seeds, etc., and discuss how the seed structures are adapted to air transportation.
7. Put healthy plants in two clean glass jars. Pump the air out of one and seal both. Keep out of direct sun-

THE NITROGEN CYCLE



light. Plants in jar with air supply will live longer.

8. If an aquarium is available, discuss proper balance.

**Cutting off man's air supply will cause him to suffocate.**

Activities

1. Discuss causes of suffocation that relate especially to children—drowning, cellophane, abandoned refrigerators, other enclosures. Emphasize the danger of playing with anything which could block air supply.
2. Discuss why air supply in a crowded room becomes "stale." Construct graph of relationship between $O_2$ and $CO_2$ in a place where air supply cannot be replenished.
3. Have children demonstrate different methods of artificial respiration.
4. Discuss oxygen supply problems in space travel. (Possible sources are compressed oxygen, oxygen from plant life.)
5. Make safety posters related to these hazards.

**Pollution replaces oxygen in the air with poisonous substances, making air harmful to breathe.**

Activities

1. Observe haze which settles over populated areas. Discuss causes—vehicle exhausts, industrial smoke, smoke from ashpits, dust.
2. Individually or in a class group, walk through the neighborhood observing and recording sources of air contamination.
3. Discuss what individuals can do to prevent air contamination:
    a. Maintain oxygen supply in ashpit to prevent smoke.
    b. Burn refuse only in the afternoons when there is usually some air movement (check local regulations on refuse burning).
    c. Install exhaust devices in automobiles.
4. Collect pictures and articles concerning air pollution.

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Field trips to the weather station, Lowry Air Force Base, and to the U. S. Weather Bureau at Denver's Stapleton Field may be arranged.

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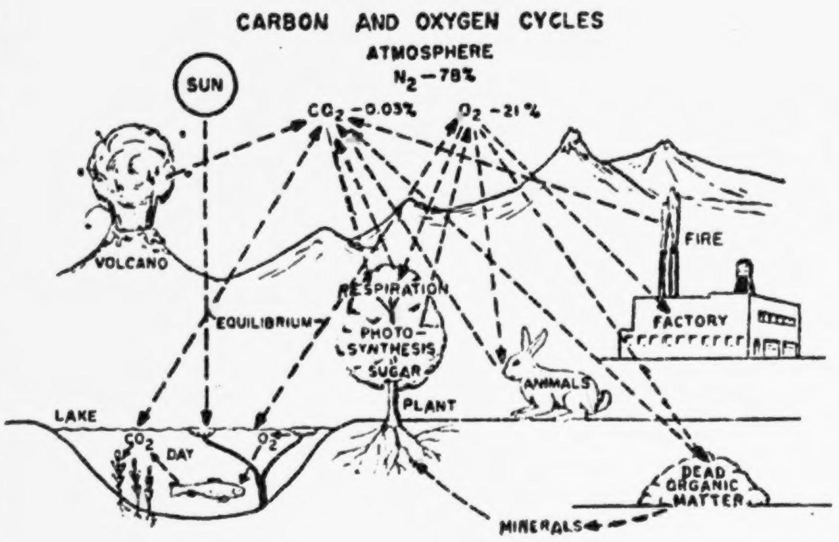
# AIR - *Junior High*

**Air moves, contracts with cold, expands with heat, has weight, contains oxygen, carbon dioxide, nitrogen and moisture.**

Activities

1. Determine percentage of each component in air.
2. Fill a balloon with air, seal and place in cold environment. Observe the decrease in size. Place same balloon in a hot environment. Suspend balloon so that it is not touching anything; increase heat until balloon breaks from expansion of air.
3. To demonstrate that air has weight, weigh a bicycle tire, add several pounds of air and reweigh tire.
4. Seal a glass jar, cool and observe moisture which condensed from air.

NOTE: While these general science activities are not closely related to conservation, the above concepts should be developed in science in order to understand the nature of air.



**Air is essential to the survival of plant life.**

Activities

1. Place a healthy plant in a glass jar. Pump out the air seal tightly. Observe death and decay of plant.
2. Demonstrate oxygen-carbon dioxide cycle by building a balanced aquarium. Animals (fish) breathe in oxygen and exhale carbon dioxide. Plants inspire carbon dioxide and expel oxygen. A proper balance of the two gases is necessary to maintain life. (See illustration at top of column.)
3. Discuss necessity of nitrogen in air. Add fertilizer with a high nitrogen content to a plant. Plant will thrive, producing a greater quantity of carbon dioxide as it grows.

**Air is essential to survival of animal and human life.**

Activities

1. Dangers of suffocation, especially with small children—blankets, cellophane, chests, abandoned refrigerators, small closets, etc.
2. Drowning is a form of suffocation—learn to swim, avoid very cold water for swimming, go in pairs, never alone.
3. Set up room terrarium with plant and animal balance.

**Man requires air for survival.**

Activities

1. Define suffocation. Discuss causes of suffocation—drowning, blocking of air supply by placing a pillow or piece of cellophane over mouth and nose, being trapped in an abandoned refrigerator or other enclosure.
2. Prepare a detailed chart of safety measures to prevent drowning and other forms of suffocation. Include methods of artificial respiration.
3. Discuss man's adaptation to living at higher altitudes where oxygen content of air is less. (Increase in red corpuscles.)

**Pollution makes air dangerous to breathe.**

Activities

1. Light a piece of paper and have students breathe small amounts of smoke. Smoke is harmful because the carbon in it replaces oxygen in the air. Discuss what would (or does) happen if all the ashpits in the city burn at the same time.
2. Observe haze over city, especially early in the morning when air is not moving. Discuss major causes of haze—vehicle exhausts, industrial smoke, smoke from ashpits, dust.
3. Discuss major centers of air pollution—Los Angeles, New York, Chicago, Denver. How has Pittsburgh controlled industrial air pollution? How critical is the air pollution problem? According to Mr. Jack Kaplan in the article "Our Unclean Air," *Today's Health* (March, 1962) LX, No. 3, "States spent only $1.6 million on air pollution control in 1960 and half that amount was spent by California." Kaplan continues, "the populace has remained apathetic in most areas until aroused by such things as the 1960 New Orleans, La., asthma epidemic and the 1948 Donora, Pa., killer fog which claimed 20 lives."
4. Discuss methods of preventing air pollution.
   a. Put screens on ashpits and maintain an adequate air supply.
   b. Burn refuse only when air is moving.
   c. Install exhaust control devices on vehicles.
5. To illustrate how air can be polluted by burning trash at home, use the demonstration with a lighted candle covered with a glass. This demonstration points out that as soon as the flame uses all of the oxygen present, the flame smokes and will go out. Fire needs oxygen to burn. If the incinerator is covered too quickly after lighting the trash, it will smoke.

**Man uses air in his work.**

Activities

1. Observe school thermostat. Thermostats for heat control are operated by air pressure.
2. Find examples of sand blasting on building facades, statues and tombstones. Sand, forced by air, can cut into hard surfaces.
3. Demonstrate atmospheric pressure at work with a vacuum sweeper. Atmospheric pressure pushes air into the vacuum created by the sweeper fan.
4. Discuss air pressure in tires, balls, air mattresses, rubber boats, etc.
5. List the air driven tools in machine shops—air hammers, air drills, air wrenches.
6. Discuss "painless dentistry." Compressed air enables new drills to revolve at very high speeds without heating and causing little pain.
7. List occupation hazards which result from improper oxygen supply:
   a. Silicosis—breathing particles in mining and milling processes. Remedy—masks.
   b. "Bends" or caisson disease—caused by too rapid decrease in air pressure after working in pressurized caissons or when skin diving. Remedy—decompression chambers.
   c. Pressure hazard and generation of proper oxygen supply in space travel.

**Air transportation is possible because air is dense enough to support considerable weight.**

ACTIVITIES

1. Demonstrate air lift on a toy plane by use of a fan. Explain that the difference in pressure above and below the wing caused the lift.
2. Discuss the problems of space travel:
   a. Weightlessness because of lack of pressure.
   b. Problems of extreme pressure when vehicle re-enters atmosphere.
   c. Air supply in flight.
3. Show pictures of a hydrofoil traveling on water and land. Air forced onto surface creates a pressure cushion which keeps the ship aloft.
4. Compare jet engines with rocket engines. Rocket engines use fuel as a direct source of power; jet engines use fuel to propel fans which compress and heat air. Expanding air at high temperatures creates a blasting force similar to a continuous explosion.
5. Discuss animals' adaptation to flight.

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*The Air Around Us.* 11 min.

*Air All Around Us.* 10 min.

*Air in Action.* 10 min.

*Air Pressure.* 11 min.

### Vocabulary

airborne
air masses
air pocket
atmosphere
barometer

carbon dioxide
chinook
cirrocumulus
cirrus
condensation

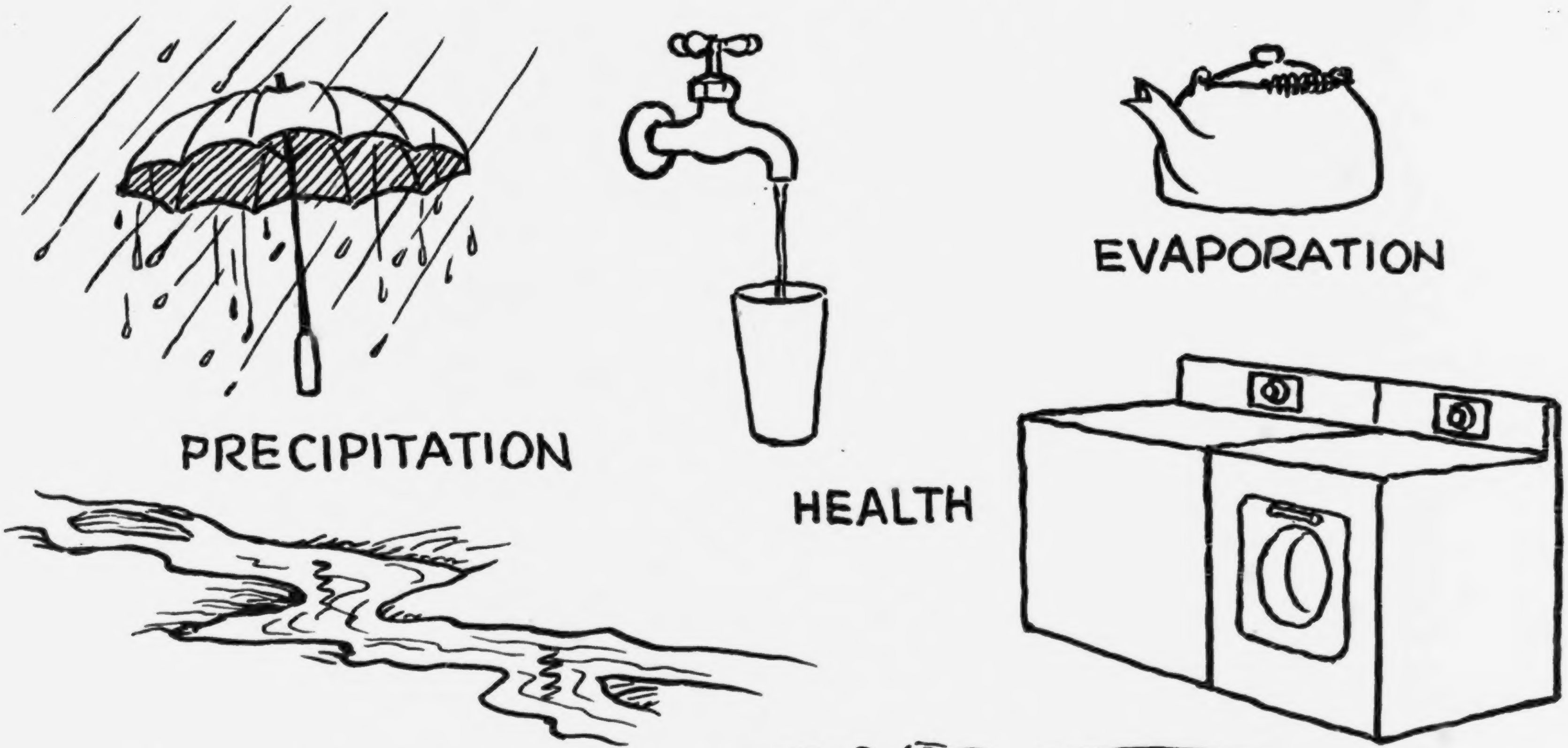
contraction
dehydrate
evaporation
frigid zone
humidity

hurricane
irrigation
isobars
meteorology
mist

nimbostratus
nitrogen
oxidize
oxygen
precipitation

shelter belt
stratocumulus
tornadoes
typhoons
vaporize

water vapor
wind erosion



IRRIGATION

# Chapter 3
# WATER
## -Primary Grades

### Introduction

In the early days of the westward movement, two separate explorations of Colorado were recorded, one by Zebulon Pike and the other by Stephen Long. Their official reports to the federal government, on the area explored, contained virtually the same information: "Unfit for human habitation, due to the scarcity of water." Pike and Long, as did other early explorers, underestimated the ability of man to retain and regulate the flow of rivers and to extend the available water supply to support a large population.

*Then* and now *water is* truly our life blood. We use it for drinking, cooking, bathing, sewage, recreation, and irrigation. But even though the supply has been extended beyond the expectations of the explorers, water still presents critical problems of distribution and remains a limiting factor in population expansion.

According to the Denver Water Board, in Denver in 1919, "270,000 persons consumed 19,638,333,909 gallons, or a daily average of 53,803,655. By 1954, consumption increased to 42,517,960,000 gallons for that year, or an average of 116,487,562 gallons a day." Denver's population is now using an average of 201 gallons of water daily per person, while a family of four uses almost 1,300 gallons on a summer day. (These figures vary according to the amount of precipitation.) The water supply is not increasing, but the human population is, and it is therefore absolutely mandatory that methods be found of supplying enough water to each person in the future.

In order to understand and conserve water, children should learn the great need for water in an expanding society, the necessity of keeping water pure, and the importance of developing the potential of the water resource to its fullest extent.

**All forms of life need water.**

ACTIVITIES

1. Through discussions and use of health pictures, lead children to see that water helps them to grow, maintains their bodies and keeps their clothes clean. By using water they look and feel better.
2. Let children list the uses of water at school (drinking water, washing hands, mixing paints, finger painting, sewage disposal, putting out fires, watering lawns and plants, keeping school building clean); at home (drinking water, bathing, brushing teeth, watering plants and lawns, cooking, washing clothes); at play (swimming, fishing, boating, waterfowl hunting, water-ice sports).
3. Put moss in two pans. Water one, keep the other dry. Observe color and consistency of both; dry moss dies.
4. Put avocado seed in water. Let children observe growth and give own descriptions and explanations.
5. Demonstrate water absorption by plants.
   a. Fit an ordinary ink blotter into a clear water glass.
   b. Place four to six bean or radish seeds between glass and blotter.

h Need
lean Water

**The aquarium is a center of interest in the kindergarten at Mark Twain Elementary School, Colorado Springs.**

c. Put enough water in bottom of glass so that blotter will stay moist, allowing seeds to grow.

d. Observe how roots of seeds will always seek water source, even if seeds are upside down; stems will likewise seek source of light.

e. Discuss how seeds grow, even when roots are not directly immersed in water. (absorption)

f. Demonstrate the wise use of water by showing how overwatering and underwatering can both be harmful.

   (1) Pour water to top of the glass with blotter and seeds in it. Seeds will die because water cuts off source of necessary $CO_2$ from air.

   (2) Allow water in another glass with seeds in it to evaporate. Seeds will die from lack of water.

6. Prepare an aquarium to demonstrate marine life habitat.
   - a. Place about two inches of washed sand in a clean fish bowl or aquarium.
   - b. Arrange two or three kinds of water plants such as duckweed or elodea in sand. Put in shells and rocks. Add water.
   - c. When water attains room temperature add guppies or other fish. Discuss $O_2$ $CO_2$ exchange between plants and fish. Note: For guppies water should be above 70°F.
   - d. Add snails. Observe how snails keep water clear of algae.
7. Prepare a bulletin board with students' drawings of themselves using water.

**Water exists in the form of a solid, a liquid or a gas, according to temperature.**

Activities

1. Melting demonstration.
   - a. Fill a pan with snow or ice.
   - b. Apply heat or set in warm place.
   - c. Ask children to guess how much water will be in the pan when ice melts.
2. Freezing demonstration—crystallization.
   - a. On a day when thermometer reads 32°F or *lower* set a pan of water outside and observe crystallization.
   - b. Discuss and examine ice—size, shape, density, texture, color. Compare ice frozen outside with ice cubes frozen in freezer.
   - c. Freeze water in containers of different sizes and shapes such as tin cans or pop bottles. Observe how tin can bulges. Observe how ice in pop bottle will expand into neck of bottle. Freeze water in a tightly closed jar to demonstrate expansion of water by freezing. Jar will crack.
3. Condensation demonstration—ice in metal cup.
   - a. Fill dry metal cup with ice cubes or chipped ice.
   - b. Observe how drops of water form on outside of cup.
   - c. Wipe cup dry and observe new formation of water drops. Water does not pass through metal. The cold produced by the ice causes condensation of water vapor present in air.
4. Terrarium—condensation.
   - a. Use old aquarium if possible rather than large jar.
   - b. Place thin layer of charcoal on bottom to help keep soil sweet.
   - c. Next, place layer of coarse sand.
   - d. Last, thick layer of good dirt.
   - e. Plant plants that need warmth and more moisture than others.
   - f. Over top of terrarium place piece of glass to completely cover.
   - g. Place in sun where it is warm for a few days. Then put a generous amount of ice on top of the terrarium. Let the children watch the large drops of water form and fall to the soil to simulate rain.
5. Vaporization demonstration—boil water.
   - a. Observe water as it begins to boil in an open pan. Some of the water changes into steam.
   - b. Boil water in a teapot with whistle spout. Discuss what causes the whistle. Discuss the steam engine.
   - c. Catch the escaping steam in a clean, cold glass jar. Observe the change from gas to liquid as steam cools. Cold makes water come out of the air (condensation). Heat makes water go into the air (vaporization).

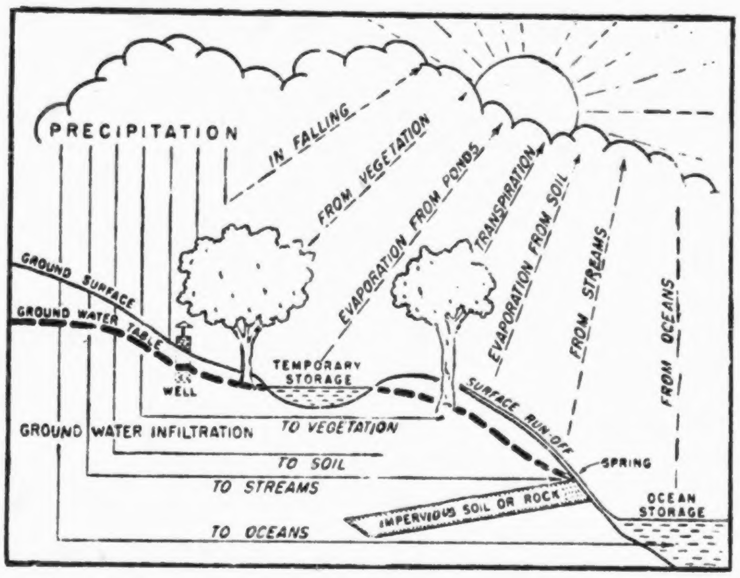
**Water is continuously evaporating from the sea, lakes, rivers, ponds and puddles. When water goes into the air it evaporates. Heat makes water evaporate.**

Activities

1. Evaporation demonstration—towels.
   - a. Wet two towels.
   - b. Place one in the sun and one in the shade.
   - c. Discuss which one dries first. Heat increases the rate of evaporation.
2. Evaporation demonstration—jars.
   - a. Fill two clean identical jars with water.
   - b. Cover one with a tight fitting lid and let both stand in the same place for several days.
   - c. Keep a record to see which evaporates first. Discuss reasons for results. Exposure to dry air accelerates evaporation.
   - d. Discuss any residue left after evaporation.
3. Let children tell of their own observations of evaporation. Tell why evaporation takes place from raincoats,

umbrellas, boots, mittens, clothing, paste, sandwiches, puddles.

4. Draw simplified pictures of the water cycle.
   a. Rain and snow fall from clouds.
   b. Water drains into streams and runs into ocean.
   c. Water exaporates into clouds which create rain.
5. Compare evaporation rate between jars with various sizes of necks. Cover one with saran wrap to deter evaporation.



The hydrologic cycle illustrated above shows the reason why wells hold water and why springs flow.

### Water falls from the air to the ground in various forms.

Activities

1. Discuss these kinds of rain: cloudburst, steady rain, mist, fog. Chilling of air with different amounts of moisture at different temperatures causes various kinds of precipitation.
2. Observe snow as it is falling and after it has fallen. Snowflakes form snow drifts.
3. Observe individual snowflakes on cold black cloth through a magnifying glass. All snowflakes have six sides, but they are not all the same shape. Each snowflake is a tiny ice crystal and not frozen rain.
4. Make salt crystals by evaporating a salt solution. Make sugar crystals by evaporating syrup. Discuss how salt and sugar crystals differ from snow crystals. Water does not crystallize by evaporation, only by freezing.
5. Read story *Where The Brook Begins,* by Bartlett.
6. Study cross-section of hail, observing center core and rings of frozen water. Why is hail white? (Air is trapped inside the hail.) Is sleet hail? (Yes, only smaller.) Both sleet and hail are frozen rain.
7. Cut paper snowflakes and snowmen. Draw hail cross-section.

### The sources which provide water for homes and industries are mountain snowbanks, streams, springs and wells.

Activities

1. Discuss what happens when sunshine and warm air cause snow to melt. What will happen to lakes, rivers and streams when snow melts? Show pictures of snow depth markers in summer and winter.
2. Trace the beginnings of the four major rivers which have their headwaters in Colorado—the Colorado, Rio Grande, Arkansas and Platte Rivers. Observe how many states benefit by these rivers.
3. Discuss sources of underground water. Springs are usually found in the mountains or in places where underground water is close to the surface. Wells must be dug to deep levels in order to tap good water sources.
4. Show why water from springs is relatively pure. Put filter paper in a glass funnel. Fill funnel with sand. Add a cloudy solution of soil and water. Filter. Observe how sand retains the mud and the water becomes clearer. Nature carries on the same process for spring water.
5. Show how home and industry are affected by water supply. Ask children to consider what would happen if they were allowed to use only half of the water they use each day. Would they be able to substitute anything for water?

### Water pollution disrupts nature's purifying processes and makes water dangerous to use.

Activities

1. Explain to children that germs (bacteria) are everywhere, especially in the water that falls in the form of rain or snow. Snow and rain water may have germs in them and should be left alone except in emergencies in order to prevent disease.
2. Make a scrapbook with drawings and photographs illustrating water pollution. Show industrial waste, sewage, dead animals, grease, oil and detergents. Unpurified water is never safe to drink. Individuals pollute water by throwing cans, paper, and garbage into water. Don't be a litterbug. It's dangerous to pollute your own water supply!
3. Bring in a consultant from the Game, Fish and Parks Department and ask him to discuss the effects of pollution on fish and wildlife. Polluted water spreads disease at a high rate, endangering humans, fish and wildlife.
4. Design a bulletin board which shows a stream polluted near its source. Show the effects on humans, fish and wildlife as polluted water moves downstream.
5. Demonstrate pollution using two jars of water. Place ¼ sheet of white paper in one jar. After several days have children notice paper causes water to become polluted.

### Water helps to make our world beautiful by supporting trees, birds and animals and creating a feeling of freshness and life.

Activities

1. Through discussion and use of pictures encourage children to tell why they like to have picnics near a lake or stream. They can wade, feel the water, watch reflections, etc.
2. Discuss different colors of water in the ocean, lakes and streams.
3. Show how bodies of water can make photographs more interesting.
4. Discuss how water can help us enjoy an area more. It

supports shade trees and wildlife with pretty colors and voices and is a source of recreation.

5. Show what happens to a beautiful area when water is drained away. Discuss dust bowl—lack of water caused wind erosion which ruined land.
6. Write a few sentences about the beauty of water. Draw pictures to illustrate each sentence.
7. Paint pictures showing people enjoying lakes and streams.
8. Make a diorama showing a lake or river. Put water birds, water plants and people in the scenes.

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### Films and Filmstrips

(Films and filmstrips without sources will be found in the *Mountain Plain Film Library Association Joint Catalog* 62-64.)

*Adventures of Junior Raindrop.* 8 min.

*How Water Helps Us.* 11 min.

*Lands and Waters of Our Earth.* 11 min.

*Snow Flakes.* 7 min.

*Treasures in Snow.* 6 min.

*Water, Water, Everywhere.* 10 min.

*What Makes Rain?* 10 min.

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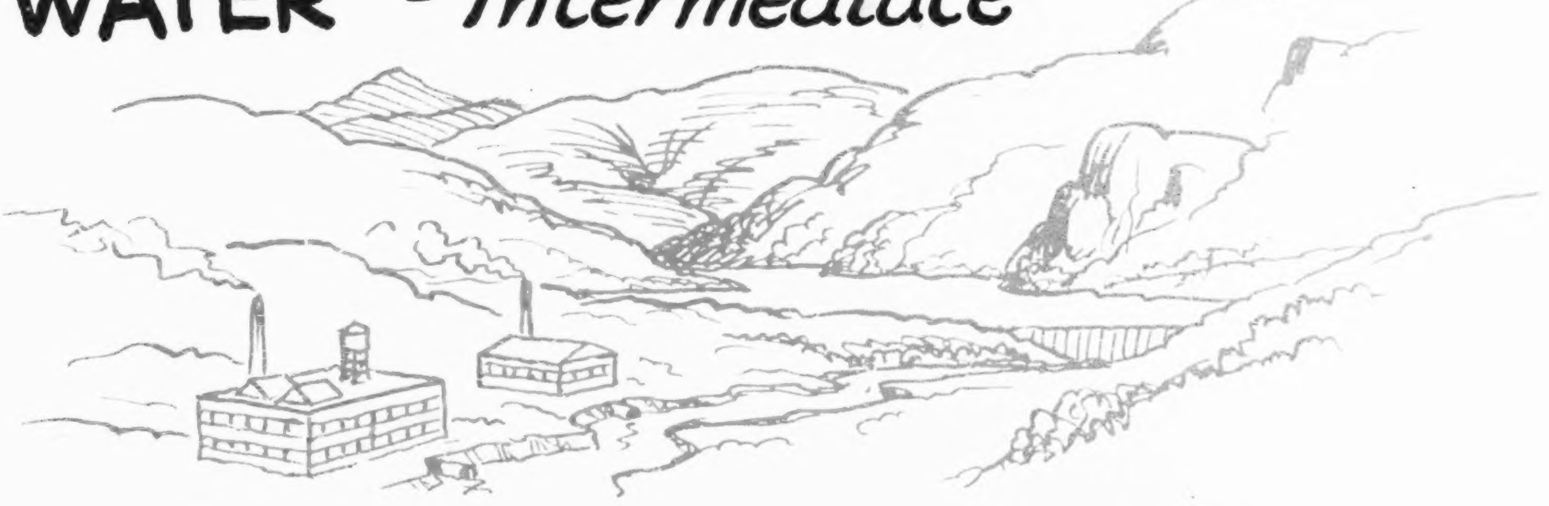
# WATER - *Intermediate*



**The hydrologic cycle is the process whereby water that falls on the land drains into the seas, evaporates and returns to the land by means of precipitation.**

Activities

1. Construct a model of a watershed which will demonstrate the nature of the water cycle.
    a. Paint marks on the banks of a small model pond, fill with water and observe evaporation using marks to determine water level.
    b. Allow water to run downstream fast enough to turn a model waterwheel.
    c. Waterwheel provides power for a pump which feeds water into suspended clouds made of cotton. Water may be fed into clouds by hand if pump is unavailable.
    d. When cotton is saturated, water will fall into pond.
2. Conduct a demonstration of evaporation.
    a. Fill a jar with water. On a piece of tape write the date and time when experiment was started.
    b. Each date note the decrease in the amount of water. Record the necessary information on another piece of tape and put the tape on jar at water level.

**This picture, taken at Rocky Ford, Colorado, shows one way to demonstrate evaporation and condensation.**

c. Continue until water has evaporated. Discuss observations.

d. Fill second jar with water and record date and time as above. Cover surface of water with olive oil or similar light oil. Observe results. Discuss experimental attempts to conserve large bodies of water by reducing evaporation through addition of surface film.

3. Draw and explain in detail the hydrologic cycle.
4. Prepare a bulletin board to illustrate the hydrologic cycle. Assign groups each to draw one phase of the cycle.
5. Give a report on the value of the hydrologic cycle to mankind.

**Water which evaporates from the sea leaves the salt behind.**

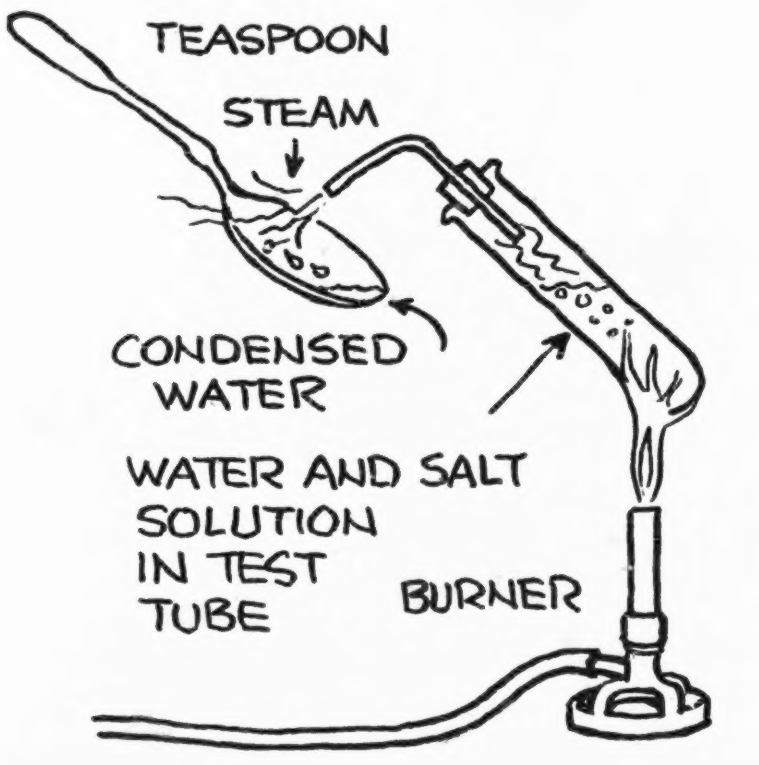
Activities

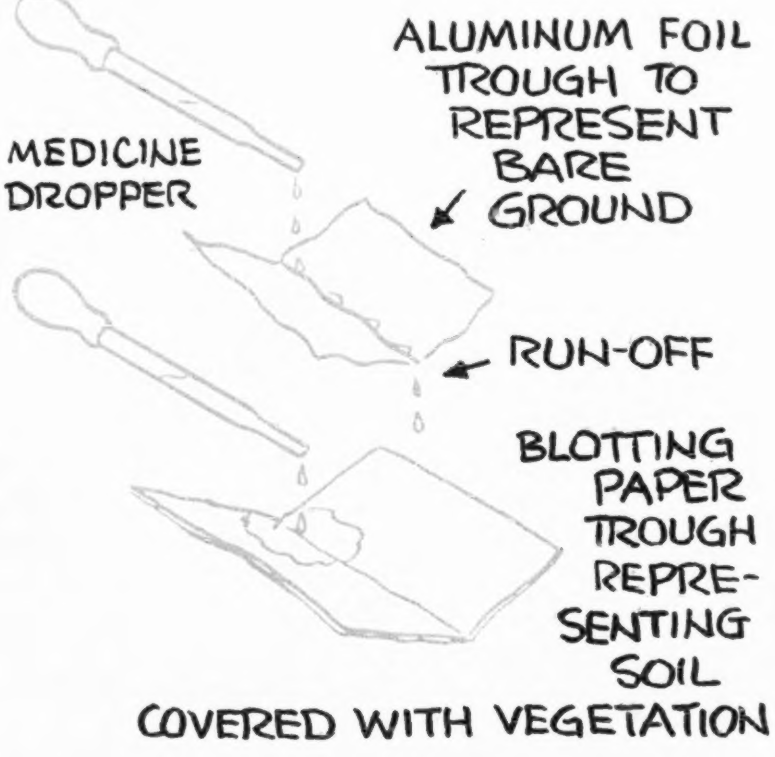
1. Place salted water in a teakettle. Let water boil. Hold a teacup over the spout. Allow the drops of water to fall into another teacup. Cool. Taste for salt content. Observe salt deposits at bottom of teakettle.
2. Look at pictures of salt flats or other large salt deposits. Salt deposits are usually found where water has been. Salt, therefore, did not evaporate with water.
3. Discuss why ocean is salty. Over millions of years, water has carried minerals (including salt) that it picked up on its journey over land into the ocean. Through water movement and increasing amounts of salt, salt deposits have been diffused throughout all the oceans.
4. Refer to teakettle demonstration and discuss how water can be de-salted for general use.
5. The above experiment can be performed by using a test tube, burner, and spoon.

**Vegetation helps the soil absorb water and slows the rate of water run-off.**

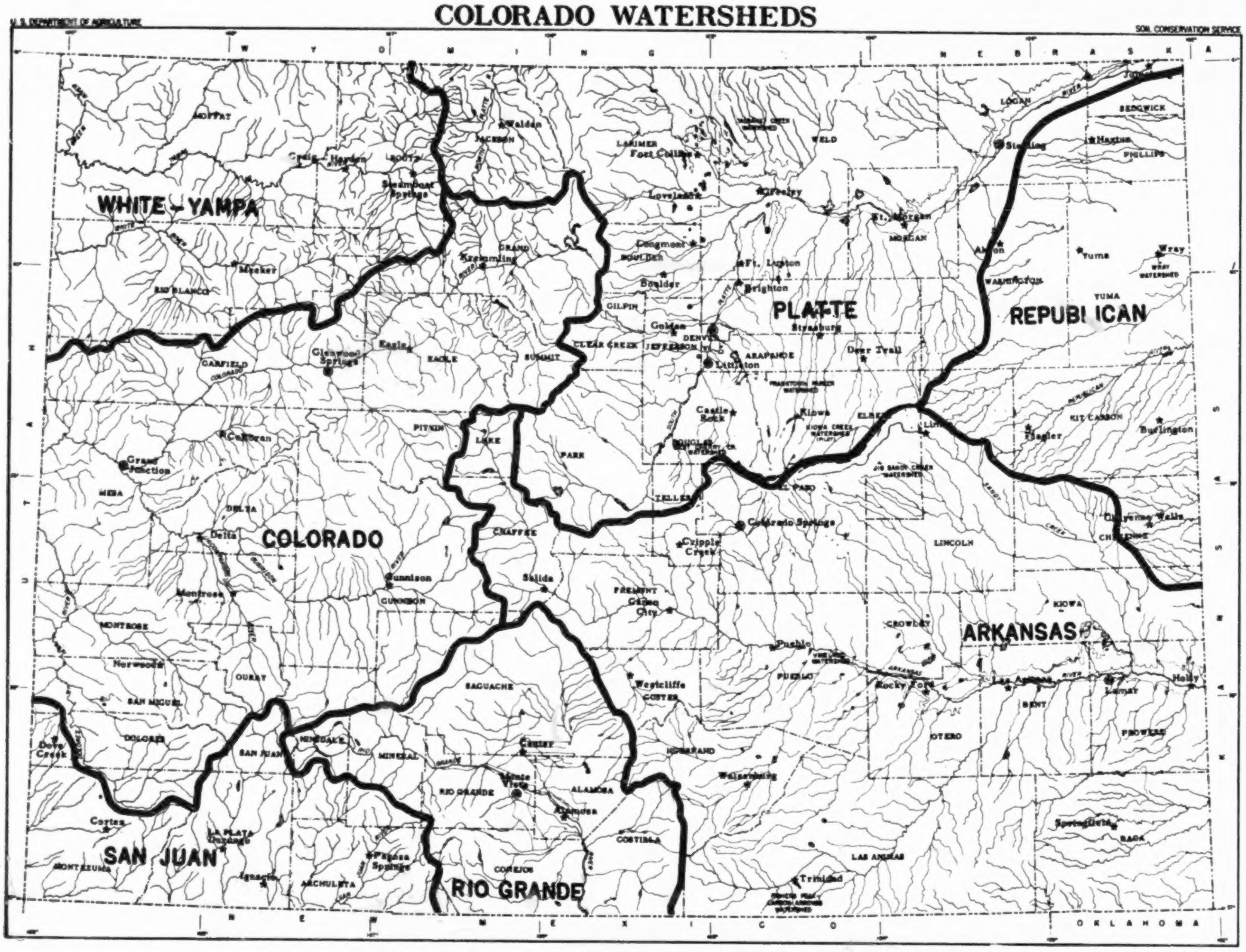
Activities

1. Demonstration of water run-off on soil with and without surface cover.
    a. Make two watertight boxes about 16 inches long, 12 inches wide and four inches deep. Use metal foil or tar paper for waterproofing.
    b. Cut a V-shaped notch about 1 to 1¼ inches deep at one end of each box. Fit a tin spout into the notch to draw run-off water into containers.
    c. Cut a piece of sod to fit one of the boxes. Trim the grass so that it will be one inch high. Fill the other box with soil from the same place. Do not take any grass, just soil. Both boxes should have the same kind of soil, one with grass and one with bare soil.
    d. Set the boxes on a table so that the spouts extend over the edge. Place a support under each box to give it slope. Place an empty fruit jar under each spout.
    e. Fill two sprinkling cans with water. Pour the water on both boxes at the same time. Pour the water steadily and at the same rate for both boxes. Hold the sprinkling cans the same height from the boxes.
    f. Study the run-off and the condition of soil before and after the run-off. What steps must be taken to ensure the wise and proper use of soil?
2. A simple experiment can demonstrate comparing run-off by using a blotter and aluminum foil.
3. Distinguish run-off from normal flow of water. When




MEDICINE DROPPER
ALUMINUM FOIL TROUGH TO REPRESENT BARE GROUND
RUN-OFF
BLOTTING PAPER TROUGH REPRESENTING SOIL COVERED WITH VEGETATION

## COLORADO WATERSHEDS



The watershed map above shows the headwaters of several large river systems in Colorado. Notice that all rivers flow out of Colorado, the top of the continent.

does run-off occur? How is the normal flow of water maintained?

4. Prepare a bulletin board illustrating flood damage resulting from bare soil.

**A watershed is an area of land which "sheds" its water into a stream. There are seven major watersheds in Colorado. Each is made up of small stream watersheds.**

ACTIVITIES

1. Draw a cross section of a watershed. Show stream and tributaries, slope of land and variety of cover (trees, shrubbery, grass, crops). Not all watersheds are mountainous regions.
2. Construct a relief map of Colorado. Show the seven watersheds and the major rivers and tributaries draining the areas. Label each. (Watershed maps available from Colorado Soil Conservation Service, State Services Bldg., Denver, Colorado.)
3. Trace the sources of four major streams which have their headwaters in Colorado — the Colorado, Rio Grande, Arkansas and Platte Rivers. What other areas in addition to Colorado benefit from these rivers?
4. Discuss methods of retaining water in a watershed area—planting trees, other vegetation, storage reservoirs. See previous "run-off demonstration" for absorption capabilities of covered soil.
5. Compare Colorado watersheds, which depend mainly on winter snows for their water supply, with watersheds in other areas, which depend on year-round precipitation.
6. Discuss the effects of forest fires on the watershed and the communities located in it.
7. Give an illustrated report emphasizing the importance of proper watershed management. Use pictures of floods and silt damage. Discuss man's dependence on watersheds.

**The impact of a raindrop on unprotected soil breaks up the soil and causes erosion.**

ACTIVITIES

1. Demonstrate how raindrops break up soil.
   a. Set a jar lid (saucer will also work) filled with soil in the center of a large sheet of paper or cardboard (two or three feet square).

b. With an eyedropper, release a few drops of water from a height of several feet so they strike the soil. Examine the soil. Examine the paper. What is the condition of the soil. Do the splattering drops carry soil with them? How far does the splash extend?

c. Repeat above, placing both soil and new paper at a sharp angle to represent sloping field. Observe the difference in splash down hill and up hill. How do you account for the fact that streams running nearly level from farmland appear muddy after rains? (Water carries fine particles of silt which do not settle.)

d. Repeat above with sod-covered soil. Do the splattering drops carry soil? Does the splash extend as far as the drops from the bare soil?

**Erosion is the wearing away of the land by the forces of wind and water.**

Activities

1. Investigate an area of the playground which has a steep slope. Note how the water has washed away the soil. Identify the beginnings of small gullies.
2. Look at pictures of the Colorado Sand Dunes or other sand dunes and discuss the effects of wind. Look at pictures of the Colorado dust bowl of the 1930's. Has this land been reclaimed? How? (Through the planting of grasses which hold the topsoil.)
3. Compare sheet erosion and gully erosion. Sheet erosion is caused primarily by the impact of individual raindrops on a slope; gully erosion is caused by concentrated run-off.
4. Discuss methods of preventing erosion on croplands—contour plowing, crop rotation, strategic tree planting.
5. Draw pictures of examples of erosion observed in the neighborhood.

**Destruction of soil and property by flooding can be controlled by a well-managed watershed.**

Activities

1. Count the number of tributaries of the main stream of a watershed. Discuss what would happen if heavy rains cause each to overflow. What would happen to the land downstream?
2. On a model or drawing of a watershed insert several dams below the points where major tributaries flow into the main river. How will these dams affect flooding in downstream areas. What other beneficial effects besides flood control do dams have? Discuss TVA, Colorado Big Thompson Project, Frying Pan Arkansas Project.
3. Repeating run-off experiment discuss causes of and remedies for a bare watershed.

| *Cause* | *Remedy* |
|---|---|
| a. forest fires | systematic replanting |
| b. over-grazing | limiting amount of stock to available food supply |
| c. poor cultivation methods | contour plowing |
| d. decreasing the quality of the soil by planting the same crop every year and by not resting soil | crop rotation with a "Sabbath" for a section of land at proper intervals |
| e. steep slopes that do not absorb water | building fills, small dams; planting slope with grass or tenacious vines or bushes. |

4. Well-planned timber harvests do not damage the watershed but often improve the water yield. Study this.

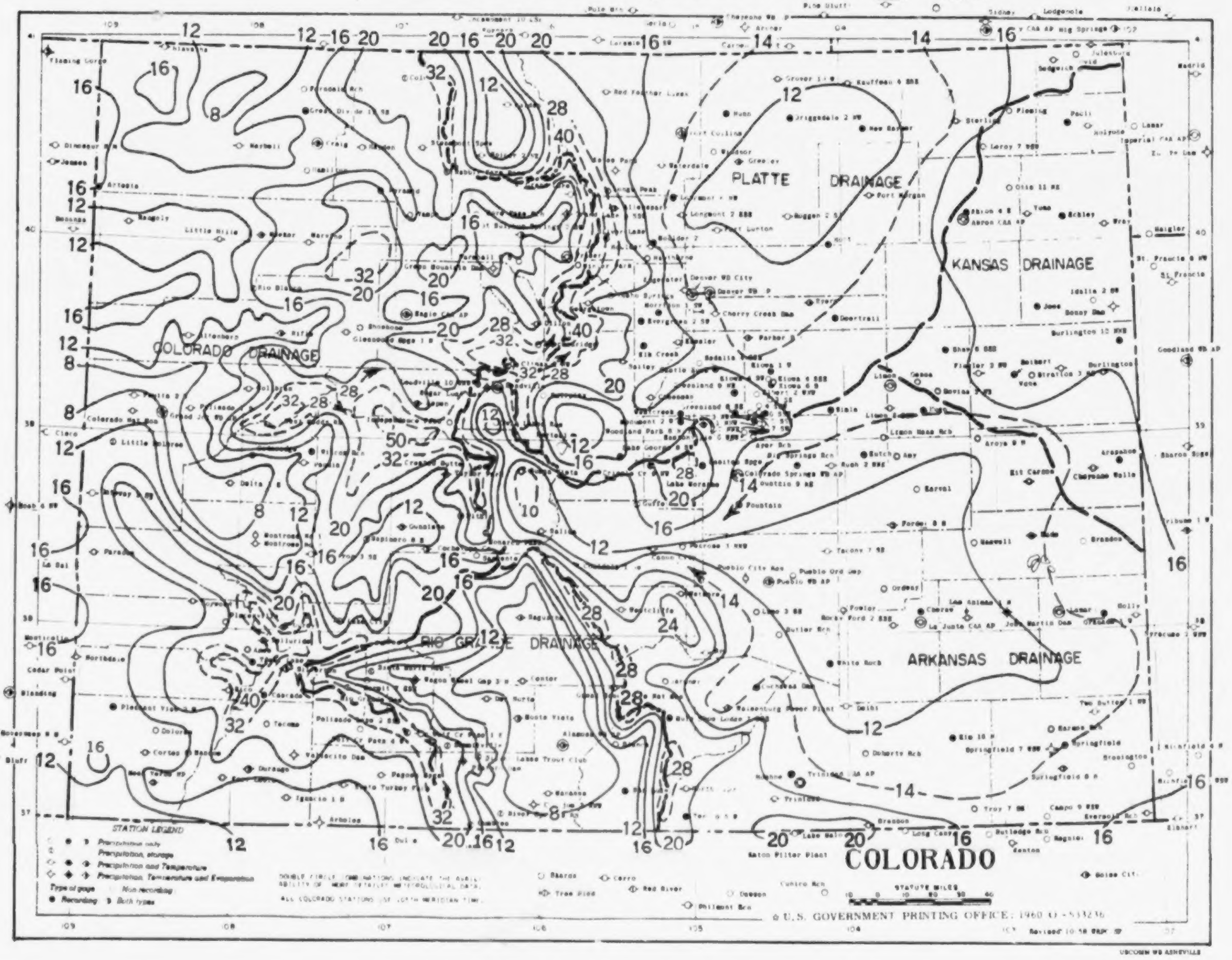
**The movement of the population to the city and the general expansion of population have caused severe problems in providing water. Populations outgrow original small water supplies of small communities.**

Activities

1. Find out the number of people living in your area in 1900, 1910, 1920, 1930, 1940, 1950 and 1960. Make a line graph showing increase or decrease in population. Do the same thing for an area not like your own. (Compare rural with urban area.) Discuss what would have happened (or did happen) if the water supply for both areas had remained constant in the last sixty years.
2. Discuss sources of water supply for rural and urban population. Farms have individual wells serving only one family. Urban areas must have a central water supply.
3. Circle on a map the main source of water for your area. Are there any dams? Has the water been transported by pipelines or through water tunnels? Where does the water go after you are through with it?
4. Find out how much water is consumed in your area daily. (Contact local water board.) Find out rate of population expansion. (Contact local chamber of commerce.) Will present water supply meet future needs? Discuss possible new sources of water—storage dams, re-use, rationing.
5. Prepare a bulletin board showing all the ways in which water is used in the city—domestic, industrial, recreational, for irrigation.

**Denver, Colorado's first large storage reservoir is held back by Cheesman Dam, built in 1905. The dam is constructed of huge blocks of granite. Cheesman Reservoir was at capacity level when this picture was taken.**

Mean Annual Precipitation, Inches


PLATTE DRAINAGE
KANSAS DRAINAGE
COLORADO DRAINAGE
RIO GRANDE DRAINAGE
ARKANSAS DRAINAGE
COLORADO
STATION LEGEND
STATUTE MILES
U.S. GOVERNMENT PRINTING OFFICE: 1960 O-533236

6. Visit your city utilities department and find out days of peak usage of water during the past year. Make a bar graph of these dates and explain their probable causes.

**Water is a source of recreation. Fishing, swimming, boating and ice-skating are the most common activities on water.**

ACTIVITIES

1. Have students list all forms of water recreation in which they have taken part.
2. For each water activity make a report on equipment needed and skills involved.
3. Prepare a bulletin board showing water safety rules in general and specific safety procedures for each water activity. The most important water safety rules are: learn to swim, and wear life belts when necessary. Discuss drownings which were caused by carelessness, not knowing how to swim and not using life belts.

**Pollution disrupts nature's purifying processes and makes water dangerous to use.**

ACTIVITIES

1. Visit a local water purifying plant to see how water is deliberately shot into the air in order to purify it.
2. List ways in which water is polluted—industrial waste, sewage, dead animals, grease, oil and detergents. Discuss relationship between litterbugging and pollution.
3. Visit a sewage disposal plant to observe methods of water purification.
4. Make a map of areas served by one stream. How many times is water polluted and treated before it reaches the sea? Where is water most desirable to drink?

**A sixth grade student at George McMeen School in Denver demonstrates the three forms of water, from left, gas, liquid and solid.**

5. Discuss necessity and desirability of laws to protect downstream areas from pollution. It is more efficient and economical to treat pollution at its source than after water has been contaminated.

**Rainfall affects growing things—determines the crops which can be grown. The average rainfall in Colorado varies widely. The high mountain passes receive the most.**

ACTIVITIES

1 Study precipitation map.
2. Demonstrate the three forms of water: liquid, solid, and gas.

**The oceans are important to human life.**

ACTIVITIES

1. Study the ocean as a source of food supply. Ask a committee to arrange an exhibit, or make charts of pictures cut from magazines showing foods from the sea.
2. Have a committee collect pictures of ships and boats to show ocean transportation.
3. Show exhibits of water sports.
4. The ocean affects the climate of land for some distance inland. Study ocean currents and land areas as to average temperatures.

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# WATER - *Junior High*

**Air contains varying amounts of water.**

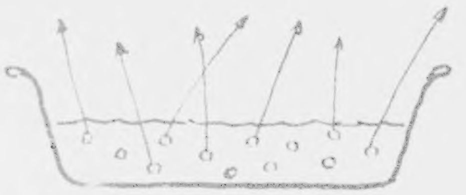
ACTIVITIES

1. Demonstrations can be set up using test tubes or other containers to show evaporation phenomena in a closed container, open container, heated container, and in moist and dry air. Diagrams and demonstrations may be as follows:
   a. Heating increases the molecular speed and more molecules leave the pan in a given time. This can be shown by heating a test tube with ¾ inch of water in it over a burner.

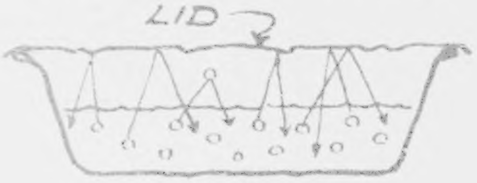
**Water circulates in quiet ponds.**

ACTIVITIES

1. Use two bottles to show circulation of $H_2O$ in quiet ponds. (See illustrations on page 28.)
2. Convection currents described:
   a. Water is most dense at 4°C or 39°F.
   b. As it freezes its density becomes less, thus ice floats.
   c. Therefore $H_2O$ that is cooling to freezing temperature will sink to the bottom of lakes and ponds when it reaches 39°F. Water colder than 39°F becomes lighter and floats.

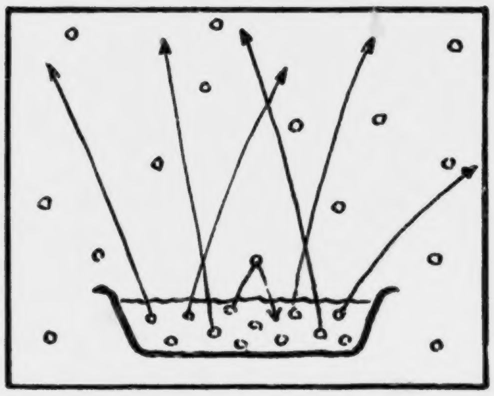


OPEN PAN OF WATER



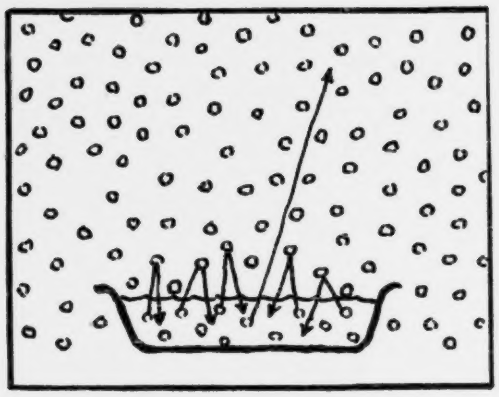
COVERED PAN OF WATER

ROOM WITH DRY AIR (RAPID EVAPORATION)



LOW CONCENTRATION OF WATER MOLECULES IN THE AIR OFFERS FEW OBSTACLES TO EVAPORATION.

ROOM WITH WET AIR (SLOW EVAPORATION)



HIGH CONCENTRATION OF WATER MOLECULES IN AIR. EVAPORATING MOLECULES STRIKE THOSE ALREADY IN THE AIR AND REBOUND INTO THE PAN.

d. The shifting of surface water to a lower depth and colder water (below 39°F) to the surface set up a kind of convection current that gives creatures living in the far depths fresh air necessary for life.

e. This process reverses itself in the spring.

**Normal fresh water contains air which will support fish.**

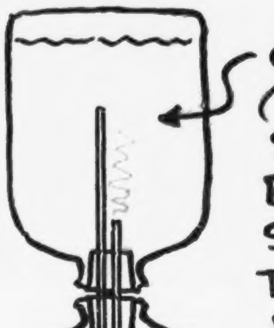
Activities

1. Take two quart jars and put fresh water in one, boiled water in the other. The fish will come to the surface often for air in #1 but will not in #2. This shows that air is dissolved in fresh water and is not present in boiled water.

**Water is unevenly distributed geographically, and the quantity or precipitation varies.**

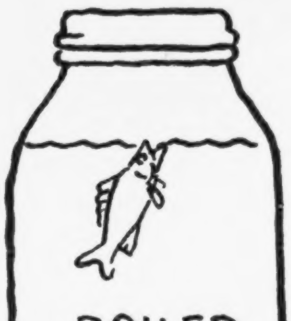
Activities

1. Locate the larger bodies of water on a world map. Is there any order in the way these bodies of water are distributed? What relationship does water supply have to population location?
2. Examine and discuss precipitation maps. What is the major source of precipitation for your area: The Western Slope of Colorado receives its precipitation from cold air from the northwest and moisture from the Pacific Ocean. The Eastern Slope receives its precipitation from cold air from the northwest and moisture from the Gulf of Mexico. Explain these facts on a weather map.
3. Discuss the following in relation to air:
   a. Major cells of air circulation, rotation of the earth and the prevailing winds.
   b. Formation and characteristics of air masses and their movements.
4. Demonstration of convection currents.
   a. Fill small bottle with hot colored water. Fit small bottle with rubber stopper and two pieces of glass tubing.
   b. Place small bottle containing hot colored water into a larger container with cold water.
   c. Observe circulation of water until temperature equalizes.
5. Draw two maps of your area, one showing major bodies of water, the other showing air patterns and precipitation sources.

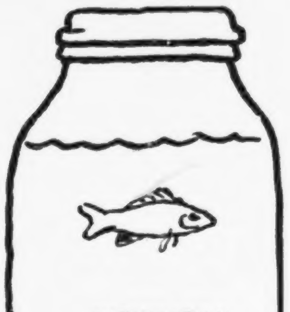


COLD WATER (CLEAR) IS SLIGHTLY DENSER AND SETTLES TO THE BOTTOM, PUSHING THE WARM WATER UP TO THE TOP.

HOT WATER (COLORED)



MUCH AIR DRIVEN OFF



PLENTY OF AIR

**The top of the zone saturated with ground water is known as the water table.**

Activities

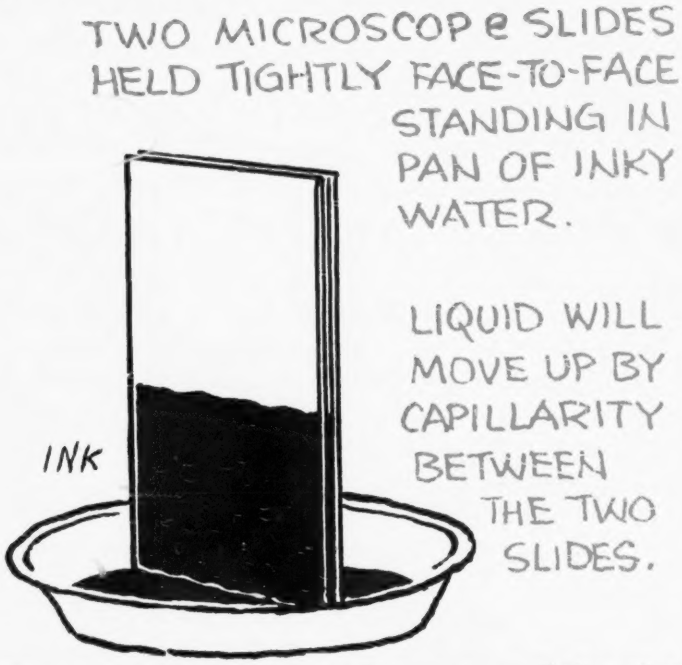
1. Draw a diagram of a cross section of soil showing water table and ground water. Ground water is the reservoir of water which lies below the surface of the earth. Surface water is that which is standing or running on the surface of the earth.
2. Try to obtain drilling records from local wells. Note the levels at which water was found and present levels. Compare depth of new wells with depth of wells drilled 10 to 50 years ago.
3. Discuss changes in the level of ground water throughout the year, from year to year and from place to place.
4. Demonstrate the operation of force pumps and lift pumps in bringing water to the surface.
5. Construct a model of the water table by alternating layers of soil, rock and sand in an aquarium. Pour in water until ground is saturated to the desired point. Place a length of glass tubing next to the glass wall of the aquarium and watch the water level rise, as in a well.
6. Invite local soil conservationist to explain water table in detail.
7. Visit an artesian well.
8. Collect samples of water from wells, city supplies, rain or snow, springs, refrigerator defrosting, etc. Place four ounces of each sample in a clean, labeled pint jar. Add one level teaspoon of soap flakes (not detergent). Shake for suds which will determine the amount of softness. Make lime water, epsom salts water, table salt water. Test these in the same manner for softness. Test the various samples with litmus paper. Demonstrate how water may get all these chemicals as it percolates down to the water table.

**Through the processes of infiltration and percolation, water returns to the water table.**

Activities

1. Fill hurricane lamp chimneys or lengths of large diameter glass tubing with various types of soil. Add equal quantities of water to each container and observe the rate of percolation through the soil.
2. Determine the weight of water absorbed by the soil samples by weighing them before and after the percolation demonstration. Which samples were the most absorbent? Why?
3. Determine the rate of ground water infiltration by removing both ends from a one quart fruit juice can. Insert the can to a depth of two inches in a variety of localities such as:
   a. Ungrazed woodland.
   b. Grazed woodland.
   c. Grazed pasture.
   d. Cultivated field.
   e. Park with grass cover.
   f. Stream bank.

   Add one quart of water and then measure the amount of water that has infiltrated the soil at the end of each minute for ten minutes, then every ten minutes or every hour depending on the rate of water movement. Measure from the top of the can to the water level with a ruler. Compare the rates of infiltration.
4. Use percolation apparatus to demonstrate capillarity by placing ends of tubing in water and observing the rise of water through the soil. Use microscope slides held together with rubber bands. Place ends in pan of ink as shown.


TWO MICROSCOPE SLIDES HELD TIGHTLY FACE-TO-FACE STANDING IN PAN OF INKY WATER.
LIQUID WILL MOVE UP BY CAPILLARITY BETWEEN THE TWO SLIDES.
INK

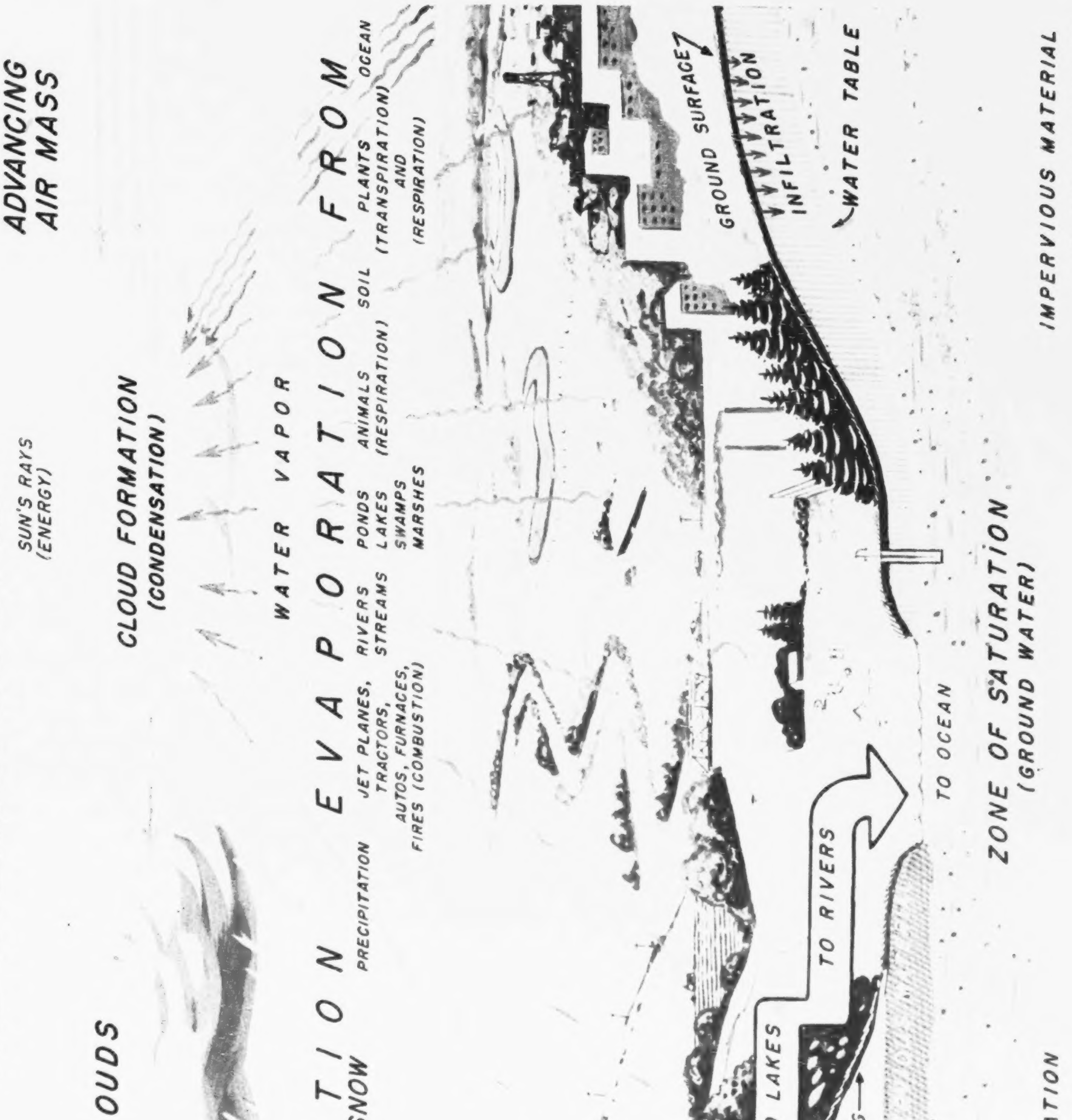
The illustration above shows how to demonstrate capillarity action. If students have been introduced to "adhesion of water molecules," the explanation can be quite complete.

**The hydrologic cycle provides the earth with a self-replenishing and self-depleting water resource.**

Activities

1. Cover a terrarium with a large piece of glass or Saran wrap. Observe the water cycle that occurs within the closed terrarium (evaporation, condensation, precipitation).
2. Observe and measure the rate of evaporation of water from:
   a. Containers of water exposing different surface areas to the atmosphere. Discuss the effect of surface area on evaporation.
   b. Identical containers of water, one placed in a warm area and another in a cool area. Discuss the effect of temperature on evaporation.
   c. Identical containers of water, one which has a fan directed over its surface. Discuss the effect of air circulation on evaporation.
3. Determine and discuss the dew-point on a day when the humidity is high and on a day when the humidity is low.
4. Have students use the following terms in writing a paper accurately describing the hydrologic cycle: solar energy, evaporation, transpiration, sublimation, condensation, precipitation, percolation, infiltration, capillarity, watershed, surface water, water table, plants, animals, wells, springs, rivers, lakes, oceans, clouds, rain, snow, hail.
5. Use diagrams and illustrations to discuss the processes involved in the hydrologic cycle.

THE HYDROLOGIC CYCLE


SUN'S RAYS (ENERGY)
ADVANCING AIR MASS
RAIN CLOUDS
CLOUD FORMATION (CONDENSATION)
WATER VAPOR
PRECIPITATION
RAIN, SLEET, HAIL, SNOW
EVAPORATION FROM
PRECIPITATION
JET PLANES, TRACTORS, AUTOS, FURNACES, FIRES (COMBUSTION)
RIVERS STREAMS
PONDS LAKES SWAMPS MARSHES
ANIMALS (RESPIRATION)
SOIL
PLANTS (TRANSPIRATION) AND (RESPIRATION)
OCEAN
SURFACE RUNOFF
TO STREAMS
TO LAKES
TO RIVERS
TO OCEAN
GROUND SURFACE
INFILTRATION
TOPSOIL
SUBSOIL
ZONE OF PERCOLATION
SPRING
WATER TABLE
PARENT MATERIAL
ZONE OF SATURATION (GROUND WATER)
BEDROCK
DEEP PERCOLATION
IMPERVIOUS MATERIAL

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

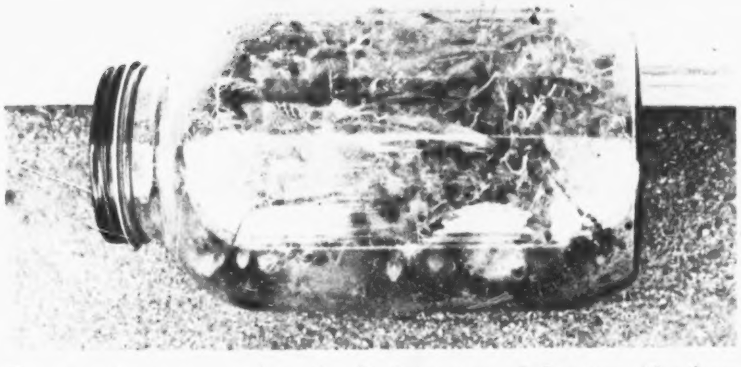
**Vegetation returns water vapor to the hydrologic cycle through the process of transpiration. (Organic Cycle)**

ACTIVITIES

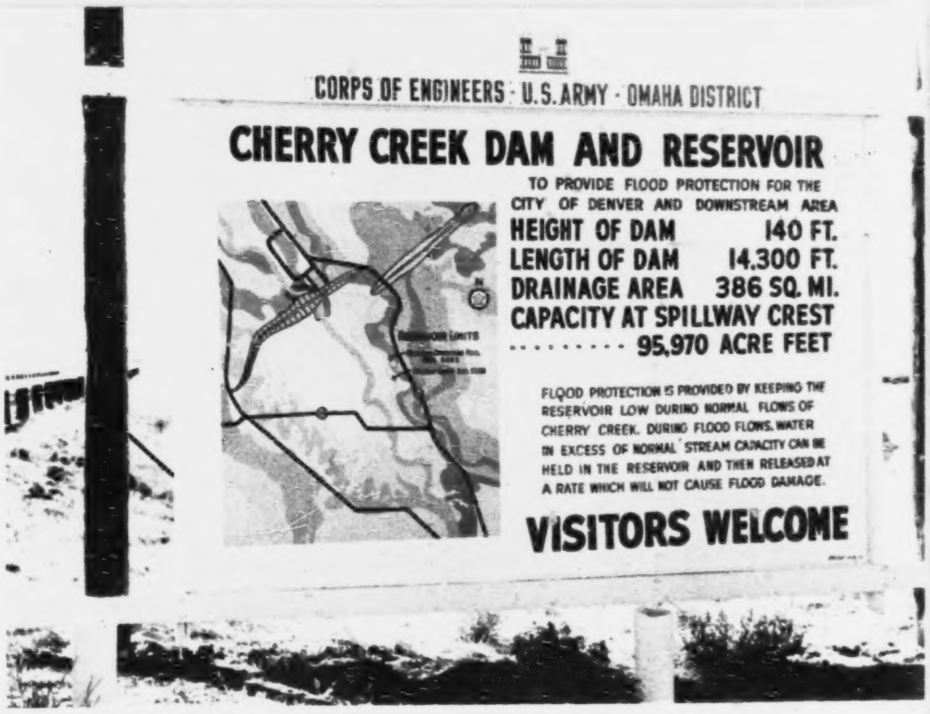
1. Define transpiration ("exhalation of vapor through the skin or from the surface of green tissues in plants"). Discuss transpiration as an important part of the hydrologic cycle.
2. Examine cross-sections of leaves with a microscope to observe the structures through which water is eliminated from the leaf.
3. Discuss the ways in which plants conserve and store water within their tissues
4. Demonstrate transpiration by placing the stem of a large shoot (such as geranium) through a hole in a piece of cardboard large enough to cover a tumbler. Fill the tumbler nearly full of water, invert another tumbler over the shoot and observe the formation of moisture on the inside of the upper tumbler after a few hours.
5. Discuss the amount of water returned to the atmosphere daily through the process of transpiration from vegetation.
6. Prepare individual gallon jar terrariums with various soil conditions. Coleus, cactus, geranium seeds are good for this. Coleus, ivy, philodendron, baby's tears, live forever, and cactus are good plants for this. The amount of water should be adapted to the type of plants. This is a good project to tie units on soil, water and plants together.

   If too much water is added, lid may be removed for a day. If too little, more may be added. The hydrologic cycle soon becomes apparent. A plant community develops. These "little worlds" make nice gifts. Similar arrangements are used to transport delicate plants great distances. Children like to watch the seed germination.

This terrarium
has been sealed
for four years.



This terrarium was used in the kindergarten of Stratton Meadows Elementary School, Colorado Springs.



CORPS OF ENGINEERS - U.S. ARMY - OMAHA DISTRICT
CHERRY CREEK DAM AND RESERVOIR
TO PROVIDE FLOOD PROTECTION FOR THE CITY OF DENVER AND DOWNSTREAM AREA
HEIGHT OF DAM 140 FT.
LENGTH OF DAM 14.300 FT.
DRAINAGE AREA 386 SQ. MI.
CAPACITY AT SPILLWAY CREST .......... 95,970 ACRE FEET

FLOOD PROTECTION IS PROVIDED BY KEEPING THE RESERVOIR LOW DURING NORMAL FLOWS OF CHERRY CREEK. DURING FLOOD FLOWS, WATER IN EXCESS OF NORMAL STREAM CAPACITY CAN BE HELD IN THE RESERVOIR AND THEN RELEASED AT A RATE WHICH WILL NOT CAUSE FLOOD DAMAGE.

VISITORS WELCOME

**Water vapor returns to the water cycle directly from ice and snow through the process of sublimation. (Inorganic Cycle)**

ACTIVITIES

1. Define and discuss sublimation ("to pass from the solid to the gaseous state and again to condense to solid form without apparently liquefying").
2. Sublimation demonstration:
   a. Allow "dry ice" to evaporate. Discuss the fact that it does not first melt to a liquid.
   b. Allow iodine crystals to evaporate directly into a vapor.
   c. Take two lightly compressed balls of snow (easily obtained from a freezer unit any time of the year). Place each one in a shallow evaporating dish and weigh. Direct fan on one on a day when the humidity is low. Compare the weights of water obtained from each and calculate the percentage of water vapor lost by sublimation.
3. Discuss the effect of shade on the rate of sublimation and melting.
4. Discuss the effect of air circulation on sublimation.
5. Discuss the fact that sublimation can occur at temperatures below the freezing point of water.

**An important phase of conservation is good watershed management and flood control.**

ACTIVITIES

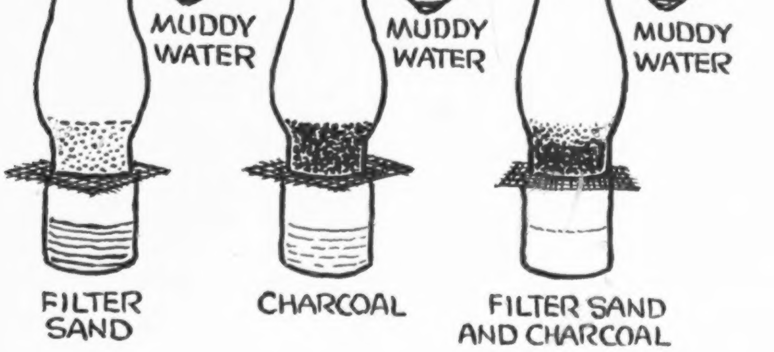
1. Discuss the importance of good farming practices and good forest management in watershed control. Conduct run-off experiment to demonstrate absorption capabilities of covered soil.
2. Prepare a bulletin board of the many excellent pictures of flood and silt damage resulting from poor watershed management.
3. Collect samples of water from streams after a heavy rain. Allow the samples to settle and observe the amount of siltage in each. Discuss the characteristics of the watersheds that supplied the stream from which the samples were taken (grass-covered, forest, cropland, etc.).
4. Have students make a drawing or a model of a farm showing methods used to reduce the velocity and silt load of surface water. Include terracing, sod waterways, contour practices and water detention systems.
5. Discuss and visit check dams in the area. How are check dams beneficial?

6. Discuss important flood control and water storage projects—TVA, Upper Colorado River Project. (Most of the projects in Colorado are designed to store water for irrigation, power and urban use.)
7. Discuss detrimental effects of erosion—unproductive land, an aid to flood waters, etc.
8. Discuss the effects of forest fires on watersheds.
9. Discuss how well-planned timber harvests do not damage the watershed but often improve the water yield.

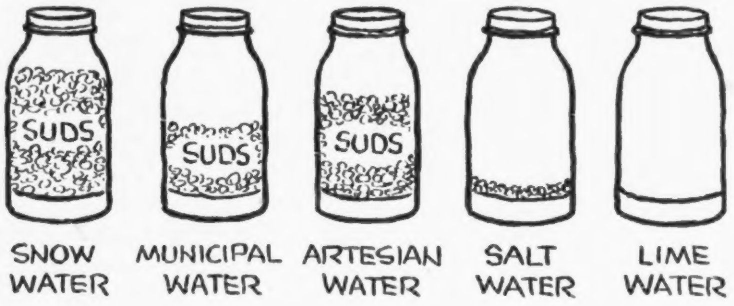
**Present sources of water must be used properly now, and expanded for the future.**

ACTIVITIES

1. Locate sources of water for the community and surrounding areas. How close is main supply? Is water transported by pipeline and tunnels as well as by streams? Show on maps major diversion projects designed to redistribute adequate water supplies.
2. All of Colorado's rivers originate in this state. Locate the source and main tributaries of the Colorado, Rio Grande, Arkansas and Platte Rivers. How many states besides Colorado are supplied with water from these rivers?
3. Discuss the value of reclamation and storage projects.
    a. Describe and discuss the Colorado Big Thompson Project and its effect on the water supply in the South Platte River valley. Do the same thing for the Frying Pan-Arkansas Project and the Upper Colorado Storage Project.
    b. Visit the U.S. Bureau of Reclamation at the Denver Federal Center to study models of reclamation projects. Write a report on the functions of the Bureau of Reclamation.
4. Have students construct a model of a city's water supply showing:
    a. Where it originates.
    b. How it gets to storage areas.
    c. How and where it is stored.
    d. How and where it is purified.
    e. How it is distributed for consumption.
    f. How wastes are removed.
5. Visit local water storage and treatment facilities. Is water purified before or after it is stored? Where does used water go?
6. Bring back a small amount of the filter sand from the water treatment plant if possible. A cup full is enough. Set up lamp chimney filters.



7. Show and demonstrate the use of purification tablets such as are in camping kits.
8. Show soap test for mineral content or hardness.



9. Show how to chlorinate a cistern (one-third of a cup of Clorox to 1000 gallons of water as it is being dumped). Discuss the need for this.
10. Invite a public health officer to visit the class to discuss water problems, urban and rural.
11. Discuss some common ways in which water is misused.
    a. Leaky faucets.
    b. Allowing water to run when unnecessary.
    c. Improper irrigation and lawn watering.
    d. Industrial waste.
    e. List others.
12. Discuss improved use, improved and enlarged storage facilities and improved methods of redistribution as primary methods of increasing our water supply in Colorado.

**The availability of water influences the survival and growth of all forms of life.**

ACTIVITIES

1. Discuss the dependence of all living things on an adequate water supply.
    a. Wildlife (waterfowl, fish, beaver, etc.) need water for dwellings as well as normal drinking requirements.
    b. The composition of plants is sometimes as much as 50 percent water. Weigh several species (including garden vegetables) dry in an oven and reweigh, calculating water loss.
    c. Discuss the primary human needs for water.
2. Have students list the ways in which they use water. Have them estimate the amount of water they use for each purpose and then calculate their individual requirement, the annual requirement for the class and the annual requirement of the community. Compare this with the capacity of the city's storage facilities. (In Denver a family of four uses one acre foot of water per year, and the total storage capacity for Denver, including Dillon Reservoir, is approximately 500,000 acre feet; 1 acre ft. = 325,581 gal.; 1 million gallon = 3.07 acre ft.)
3. Locate on state and national maps major cities which are situated near fresh water supplies. Find cities which do not have an adequate source of water. How do these cities meet their requirements for survival and growth?

4. Study the size of your community in relation to the availability of water. How will future needs be met?
5. Discuss man's responsibility in meeting the water needs of future generations as well as his own.
   a. Can water supply support the geometric expansion of population?
   b. What new sources of water are there? (Re-use, regulations limiting use, de-salting sea water, better utilization of present supply by improved storage techniques.)
   c. Are Colorado's water problems as serious as those of other states? Yes, because many states depend on Colorado for their primary source of water.
   d. Discuss water rights and who controls them. Priorities on each stream are assigned according to earliest date of filing.

**Swamp and marsh drainage can destroy wildlife habitat.**

Activities

1. Discuss the forms of wildlife that may depend upon the swamp or marsh for their supply of water—waterfowl, migratory birds, beaver, etc. (The beaver helps to build beneficial swamps and marshes. It is generally agreed that the beaver is more beneficial as an engineer than as a fur bearer.)
2. Discuss the effect that drainage would have on the wildlife populations in the area. Complete drainage would drive out existing species. Only species adapted to a dry environment would survive.
3. Discuss the objections to swamps and marshes; contamination, insect breeding, etc.
4. Locate on a map the primary area of marsh or swamp lands in the state (Federal Wildlife Reservation, San Luis Valley). Contact U. S. Fish and Wildlife Service for more information.
5. Visit a swamp or marsh in the area and observe wildlife populations.

**Water provides a valuable supply of energy in the form of electricity from hydroelectric plants.**

Activities

1. Have students map the locations of the hydroelectric power facilities in their area and throughout the state. (Some of the major plants are located in Glenwood Springs, Estes Park, Boulder and on the Big Thompson River.) Why are these facilities located where they are?
2. Discuss the uses made of hydroelectric power and what man has done and can do to increase the amount of available power.
3. Discuss the reasons why the construction of water storage facilities often includes the construction of hydroelectric power plants (to offset costs).
4. Demonstrate the generation of hydroelectric power by attaching a small generator (such as the kind used on many bicycles) to a water wheel and directing a stream of water against the wheel. Light small light bulbs with the current thus generated.
5. Have students make diagrams or construct a model of a hydroelectric power plant.
6. Plan a field trip to the Bureau of Reclamation, Federal Center, Denver.

**Efficient water management is essential to the complete needs of a community.**

Activities

1. Discuss agencies which have some control of water supply and use in the community:
   a. Water department.
   b. Health department.
   c. Park department.
   d. Highway department
   e. Soil conservation district.
2. Discuss the methods of storing water and the location of the water storage facilities in the community. Helpful information is provided in the pamphlet "The Story of the Denver Water System," Denver Water Department.
3. Discuss the ways in which the various uses of water often conflict with one another:
   a. Drainage vs. waterfowl habitat.
   b. Municipal or industrial waste disposal vs. swimming, fishing, boating.
   c. Power development vs. lake level stabilization.
   d. Waterskiing vs. swimming and fishing.
   e. Private water rights vs. public needs.
4. Discuss problems regarding the right to use water and why laws are needed to control the use of water. The mupltiple use concept of natural resources offers a possible solution to these problems.
5. List and discuss the major items of expense involved in maintaining an adequate water supply. (Dams, pipelines, tunnels, purification plants, sewage treatment plants, sewer systems.)

**An essential part of good water management is the control of water pollution.**

Activities

1. Discuss the ways by which the following pollutants reduce the usefulness of water for human consumption, irrigation and wildlife:
   a. Sewage: wastes which consume oxygen in water; pathogenic organisms.
   b. Industrial wastes: wastes which consume oxygen; chemicals, sludges; oil and greases; detergents; taste-altering wastes.
   c. Water containing silt from watershed and channel erosion.
2. Streak agar plates with water samples from various sources, incubate and examine for the growth of bacterial colonies.
3. Have students make a list of the diseases transmitted through water. Discuss sewage treatment in relation to transmission of disease by water.
4. Obtain water samples from a variety of sources (distilled, tap, lakes, streams, eavestrough, etc.) and demonstrate the following tests for water quality:
   a. Water hardness: Add 5-10 drops of soap solution (soap flakes dissolved in isopropyl alcohol) to measured volumes of the water samples in test tubes. Shake the tubes vigorously and measure the quantity of suds formed.
   b. Acidity: Moisten pieces of red and blue litmus

paper with the water sample to determine whether water is basic or acid.

5. Demonstrate the effect of chlorination on water. Chlorine is an anti-pollutant.
   a. Obtain chlorine water by adding tablet provided for home swimming pools to water, or add hydrochloric acid to a solution of sodium hypochlorite (commercial bleaching solution) in water.
   b. To one of the two test tubes containing a water sample add a few drops of the chlorine water. Allow the tubes to stand for 20-30 minutes and then streak one agar plate with the treated sample and another with the untreated sample. Incubate and check for the relative number of bacteria present as indicated by the number of colonies on the plates.
6. Visit the local health or water department to learn about methods used in controlling water purity (chlorination, fluorination).
7. Visit local sewage disposal plant to learn how bacteria are destroyed before sewage is returned to streams.

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*Beaver Valley*. Colorado Water Conservation Board, State Services Building, Denver 3.

*Boulder Dam*, 32 min.

*Cities—How They Grow*, 11 min.

*Cities—Why They Grow*, 10 min.

*City Water Supply*, 11 min.

*Clean Waters*, 21 min.

*Clouds*, 11 min.

*Clouds Above*, 10 min.

*Colorado's Water—Key to the Future*. Colorado Water Conservation Board, State Services Building, Denver 3.

*Energy in Our Rivers*, 10 min.

*Eyes in Outer Space*. Colorado Water Conservation Board, State Services Building, Denver 3.

*Ground Water*, 11 min.

*Hoover Dam*, 35 min.

*How Weather Is Forecast*, 10 min.

*Man's Problem*, 19 min.

*Microscope Life: The World of the Invisible*, 14 min.

*Modern Weather Theory*, Primary Circulation, 19 min.

*Mountain Water*, 18 min.

*Municipal Sewage Treatment Processes*, 13 min.

*Our Soil Resources* (Formation and Conservation).

*Pipeline to the Clouds*, 25 min.

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*The River*, 32 min.

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*Waters of Coweeta*, 20 min., color. Regional Forest Service, U. S. Department of Agriculture, Washington, D.C.

### Vocabulary

acre foot
aerate
alluvial
brackish
coffer dam

debris
dehydrate
distillation
dynamo
evaporation

farm pond
floe
geyser
glacier
ground water

gully erosion
hydrate
hydroelectric
hydrostatic
iceberg

infectious hepatitis
inundate
irrigation
kilowatt
kilowatt hour

leaching
levee
loam
lock
murky

penstock
pollute
porous
precipitation
protein

refuse
reservoir
rill
rill erosion
run-off water

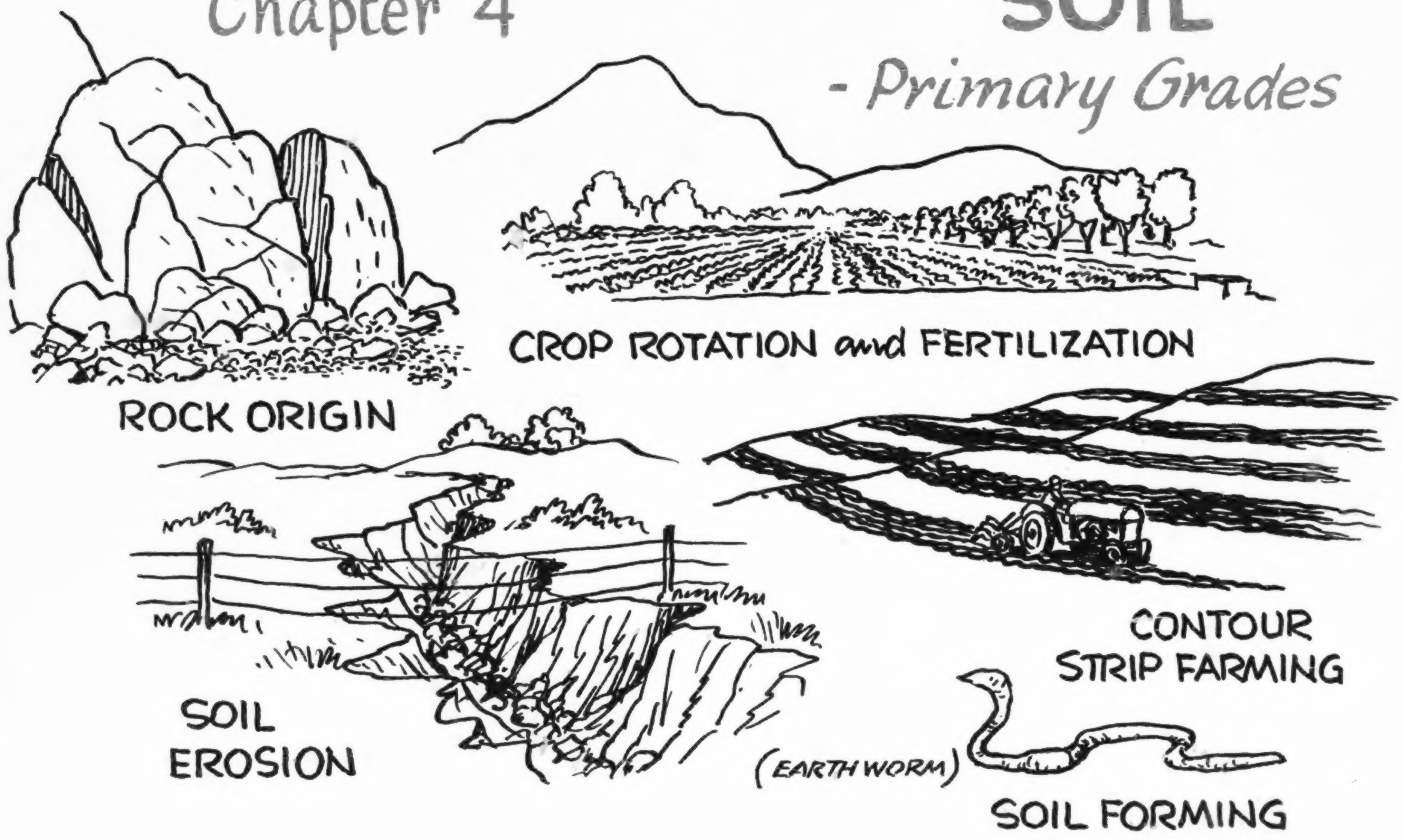
sedimentation
sewage
sheet erosion
silt
sludge

tributary
turbine
vapor
vaporize
water cycle

water erosion
watershed
watertable

# Chapter 4

# SOIL
## - Primary Grades



## Introduction

The most desecrated and mismanaged of all natural resources is the soil. Throughout the ages man has believed that the soil would always produce the food he needed at his bidding; he never considered treating the land as something delicate in need of constant care. Ancient (and "modern") cultures planted the same crops year after year, drained the soil of important minerals and paid little attention to proper irrigation. The result was often famine.

All soil has the potential of producing consistently high yielding crops. Sensible soil conservation practices such as contour farming, strip cropping, adequate irrigation and many others offer farmers the opportunity to produce all necessary food without damaging the soil. However, if soil is not properly treated, it will no longer be able to support plant life of any kind, and rains will wash the once valuable soil into rivers and eventually into the ocean.

Soil is formed from rock. Processes of weather, changes in temperature, chemical changes and decay of organic materials have contributed to the formation of soil over millions of years. But man, by improper care of the soil, can destroy in a few short seasons the work of millenia, and it will take more millenia for more soil to develop. Because soil is not renewable, because man depends on the soil for food and because the present food supply is not now sufficient for the geometrically expanding world population, man must use soil wisely, he must treat it as if it may become his last hope for survival on earth.

### Soil has many physical properties.

ACTIVITIES

1. Examine dry, sandy soil; humus or black soil; and clay soil. Place a sample of each kind of soil in a quart jar, add water and shake. Observe which settles to the bottom first.
2. Take a field trip to some nearby excavation. Observe the layers of soil. Collect samples of each layer.
3. Walk around the school grounds and collect as many different kinds of soil as possible. Each kind of soil has a specific function. Soft, black soil would not be good for the playground, but hard, sandy soil would not be good for flowers or grass.
4. Put a sample of damp soil and a leaf mixture into a small jar and label it with the date. Observe how long it takes for the leaves to mold, decay and become part of the soil.
5. List all the physical characteristics of various kinds of soils. Prepare a bulletin board showing the different kinds of soils, their characteristics and what they are used for.

### Natural forces break rock into soil.

ACTIVITIES

1. Demonstrate the primary methods that nature uses to form soil.

   a. Action of glaciers: Rub together two pieces of limestone, fine sandstone, building bricks or concrete. Observe how long it takes to rub off a few particles. Glaciers formed soil in a similar manner. When glaciers moved over the land they ground rocks together, rubbing off tremendous quantities of rock particles of all sizes. The soil of most of the north central United States was formed by the movement of glaciers.

b. Changes in temperature (weathering process): Heat a small piece of limestone over a flame or on a hot plate. Drop it quickly into a pan of ice water. The rock should break or crack after its expansion from heat and contraction from cold. Warming and cooling during day and night will also cause rocks to crack and chip into particles. Observe cracks in roads and sidewalks which were caused by changes in temperature.

c. Freezing: Fill a glass jar with water and close it tightly. Freeze and observe crack in jar. Freezing water expands with tremendous force. Water that finds its way into cracks in rocks freezes and breaks the rocks into smaller and smaller pieces.

d. Action of water: Observe smoothness of pebbles on beaches and along streams. Water rubs rocks together until rough edges are worn off. The rubbed-off particles become soil.

e. Action of wind: Wind wears away rock by blowing sand against it. Observe how windshields have been damaged by sand blasts. Observe how paint has been damaged by sand blasts.

2. Try to grow plants in "soil" made up only of rock particles. What else is necessary to good plant growth besides rock particles?

**Much of our food grows in the soil.**

Activities

1. Have children draw pictures of all the foods they eat which come from plants.
   a. Roots—carrots, radishes, beets, onions.
   b. Stems—celery, rhubarb.
   c. Leaves—lettuce, spinach.
   d. Seeds and seed pods—fruit, tomatoes, beans, peas, nuts.
2. Discuss how soil is important to plants. Put a plant with an extensive root system in a glass jar in a way that roots can be seen. Observe the following:
   a. Soil holds water for plants to absorb.
   b. Soil has plant nutrients such as minerals, nitrogen.
   c. Soil provides support for plants.
3. Prepare a bulletin board display showing how a seed planted in the soil becomes an edible vegetable.

**Soil must be used wisely in order to maintain the necessary food supply and prevent erosion.**

Activities

1. Place good, moist soil in two boxes. Plant seeds in both boxes, and water until plant shoots appear. Put one box in sun and allow to dry out. Keep the other continually filled with water. Plants in both boxes will eventually die because of improper care of soil.
2. Display a cross-section of soil. Have children examine for angle worms. Discuss how worms help to get air into the soil.
3. Make a chart showing proper and improper care of soil. Good soil needs water, sunlight and fertilizers.
4. Look for examples of soil erosion on school grounds. Eroded soil does not support plants. The soil that is washed away settles somewhere else and can cause great damage.
5. Discuss ways of conserving soil.
   a. Keeping soil covered with plants which absorb water and prevent the washing away of topsoil.
   b. Building dams to prevent water from running down a stream too fast.
   c. Preventing erosion on farms by contour plowing, tree planting, proper irrigation methods.
   d. Relate story of the Indian use of baked clay ditches for irrigation.

**Soil must have air for good plant growth.**

Activities

1. Fill jar with loosely-packed soil, pour water over soil and watch air bubbles rise to top.
2. Fill jar with clay or well packed soil and observe how few air bubbles there are.

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# SOIL - Intermediate

**Soil is formed from rock.**

ACTIVITIES

1. Demonstrate the process of soil manufacture.
   a. Rub rocks together until small particles fall off. This procedure approximates weathering process.
   b. Heat rocks, then drop into pan of cold water to show effects of expansion and contraction. Rocks will break into smaller pieces.
   c. Put pebbles in a pan and run water over them. Observe how water causes rocks to rub together. Small particles of rock break off, forming soil.
2. Have children prepare a report on weathering processes. Include changes in temperature, action of glaciers, action of water, action of wind.
3. Find examples of decayed plants in the school yard. Discuss how these contribute to the composition of soil.
4. Observe characteristics of the three basic kinds of soil —sandy soil, loam and clay. Have children feel the soils, pour water on them observing their absorption capabilities and plant seeds observing their absorption soil supports the healthiest plants. Carry out the same experiments on crushed or pulverized rock.

**Soil provides minerals, food and support for plants.**

ACTIVITIES

1. Burn leaves in a bowl. Pour water over ashes and mix thoroughly. Let water evaporate and observe mineral deposits in pan.
2. List the plant foods in the soil and discuss the importance of each.
   a. Nitrogen.
   b. Phosphorous.
   c. Potassium.
   d. Water.
   e. Air.
   f. Trace-elements.
3. Dig out a weed with soil around it from the school ground. Remove soil and observe how plant cannot stay erect without soil. Draw pictures of root systems of trees. Roots are used for support as well as for absorbing food and water.

**Wind and water erosion destroy capabilities of soil to grow plants.**

ACTIVITIES

1. Take two rectangular boxes; fill one with dry, powdery soil, the other with moist, sod-covered soil.
   b. Blow air from a fan across both. Observe drifting of dry soil.
   b. Tilt boxes and sprinkle even amounts of water on both. Allow water to run out notch at one end of each box into glass jars. Observe erosion or lack of it. Examine water run-off in jars. Observe which jar has the most sediment.
2. Walk around school grounds identifying all areas of erosion. Determine cause and discuss methods of checking erosion.
3. To show how the soil absorbs water and why all water isn't absorbed by the soil, use a sponge in place of soil. Pour water over the sponge and watch the results. Add water until it runs off. What takes place in the sponge can be compared to what takes place in the soil. Discuss the results of this demonstration.
4. Show pictures of the force of wind and water on soil—sand dunes, washed-out roads and bridges, etc.
5. Prepare a bulletin board showing the course of a flood. Include illustrations of:
   a. A calm, prosperous town.
   b. Heavy rain or snow run-off.
   c. Increased speed of running water.
   d. Crested river.
   e. Flooded area.
   f. Damage from silt.
   g. Rebuilding.

**The quality of the soil affects population location.**

ACTIVITIES

1. Show pictures of a New England coastal farm. Discuss problems early settlers had in clearing land for crops. What were the reasons for westward migration?

2. On a U. S. map identify the most fertile areas in the country—Ohio Valley, Mississippi Valley, Ojai Valley (Southern California), etc. What large cities grew up in these areas.
3. Locate fertile and non-fertile areas in Colorado. Discuss kinds of crops in different areas. Discuss population movements in Colorado during the last thirty years.
4. Have students prepare a report on the dust bowl of the 1930's. Farmers abandoned their land and moved westward. Discuss methods which were used to reclaim dust bowl land—irrigation, contour farming, etc.
5. Discuss modern population trends which are no longer directly related to the quality of the soil.

**Improved management practices protect soil.**

ACTIVITIES

1. Draw a diagram of the kinds of plant life in a typical Colorado watershed (see chapter on water)—grass and low bushes above timberline, coniferous trees, mountain meadows, deciduous trees, farm land. Discuss what would happen if disease or fire destroyed one of these elements. With no growing plants in it, the soil, instead of absorbing water, would wash down, filling stream beds and leaving useless gullies.
2. Build a simple watershed model out of plaster of paris or papier mache. Demonstrate watershed control by adding the following:
   a. Fill dams to slow run-off.
   b. Hardy grasses to prevent further erosion in gullies.
   c. Trees planted in higher regions to increase water absorption.
3. Visit a farm or have children describe farms they have seen or lived on. Have them suggest basic methods of soil conservation on a farm. In a general discussion include the following methods of soil conservation:
   a. Contour farming.
   b. Terracing.
   c. Strip cropping.
   d. Crop rotation.
   e. Fertilization.
   f. Shelterbelts and windbreaks.
   g. Drainage.
   h. Protected waterways.
   i. Gully control.
   j. Water spreading.
   k. Cover crops.
   l. Pasture improvement.

**Soil has affected the history of man.**

ACTIVITIES

1. Show how soil usage has affected the history of peoples of other times and places:
   a. History of the Nile River valley shows the importance of soil (the populated areas versus very sparse population).
   b. Destruction of irrigation systems and desecration of of the land in ancient Persia led to the desert areas of today.
   c. Other desert areas: Gobi, Sahara, Arabian, dust bowl areas in U. S.

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### Films and Filmstrips

(Films and filmstrips without sources listed will be found in the *Mountain Plain Film Library Association Joint Catalog* 62-64)

*Soil and Water Conservation.* 10 min.

*Soil Conservation with Regular Farm Equipment.* 20 min.

*Soil For Tomorrow.* 20 min.

# SOIL - *Junior High*

**Soil undergoes many changes during its long development.**

Activities

1. Show pictures of the Grand Canyon or other similar rock formations to illustrate stratification. Include top layer which supports flora and fauna.
2. Discuss the processes of soil formation.
   a. Temperature changes: Heat a rock and transfer to cold water. Rock will crack or break; small particles will break off. Discuss extreme temperature changes (volcanos, the Great Ice Age). Discuss common temperature changes (winter and summer, night and day). All contribute to soil formation.
   b. Action of wind and water: Rocks break into smaller pieces when rubbed together by water or wind. Rub two pieces of sandstone together and observe particles that rub off. Action approximates action of wind and water.
   c. Plant decay: Upper layer of soil is composed partly of decayed plant matter or humus. Decaying plants add nitrogen to soil.
   d. Chemical changes: Put vinegar on limestone or marble to demonstrate action of mild acids on soil. Bases such as alkali form salts in the soil and prevent plant growth.
3. Secure or prepare a geological time chart to illustrate process of formation of earth's surface.

**Soil is derived from one or more of four basic kinds of rock—igneous, sedimentary, metamorphic and unconsolidated.**

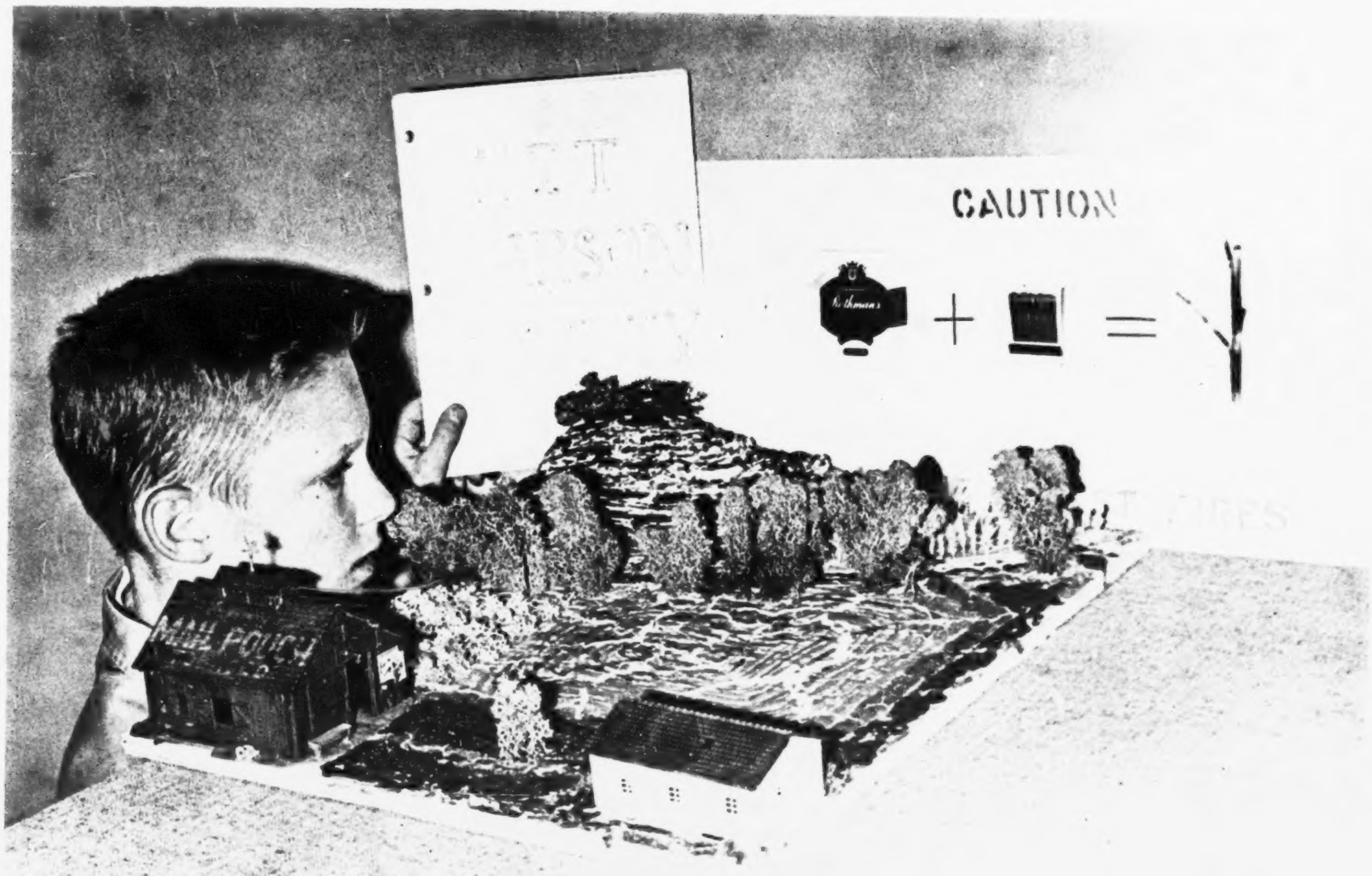
Activities

1. Fuse glass chips in a glazing oven to illustrate formation of igneous rock or rock which is produced under conditions of intense heat.
2. Pour dry, powdered soil into water, shake and let soil settle. Drain off water and allow soil to dry out. The common Colorado illustration of sedimentary rocks are sandstones and shales formed in prehistoric times by particles of soil materials settling down through waters and solidifying into rock. Factors in the process of rock and soil formation are time, weight and chemical action. Other kinds of sedimentary soil are glacial, alluvial and loess.
3. Collect examples of metamorphic rock — marble, gneiss, schist, etc. — and describe characteristics and physical properties. Metamorphic rock is rock which is changed in form due to extreme heat and/or pressure. For example, sandstone changes to quartzite, shale to slate, limestone to marble and soft coal to hard coal or graphite.
4. Examine soil for examples of unconsolidated material. This material is composed of other "parent" rocks and is transported and deposited by the action of wind and water. Some of Colorado's most important agricultural soils developed from unconsolidated material.

**Good soil is favorable to plant growth.**

Activities

1. Discuss in detail the following physical and chemical properties of soil. (Definitions from the United States Department of Agriculture, Soil Conservation Service. Denver, Colorado.)
   a. Effective soil depth. This is the depth for plant roots and storage capacity for soil moisture available to plants. Soil is classified according to effective depth as follows: Very shallow soil—less than 10 inches; shallow soil—10 to 20 inches; medium depth soil—20 to 30 inches; deep soil—greater than 36 inches. Depth to "bedrock" from the ground surface is a common illustration of effective depth of soil. The bedrock stops or inhibits the downward growth of the plant roots and limits the water storage capacity volume of the soil.
   b. Soil texture. This is determined by the amounts in the soils of the three principal separates: sand. silt and clay. (1) Clay soils—The soils with high clay content are sticky when wet. They have a high moisture holding capacity and are usually fertile. However, they are difficult to cultivate, and more power is required to work such soils. (2) Sandy soils—Soils with high content of sand are often "droughty." However, they produce good crops when the fertility is maintained and when moisture conditions are favorable. Less power is required to plow and cultivate the sandy soils. (3) Silt soils—Silt is soft floury soil material which, with some sand and clay, builds fertile and popular loam soils.



**This exhibit, prepared by social studies classes at Cheyenne Mountain Junior High School, Colorado Springs, shows industrial and conservation practices in Kit Carson County.**

c. Soil tilth. This is the physical condition of the soil that has most to do with air and water movement in the soils. Soil with good tilth keeps is shape and remains porous and open when placed in water. Soil in poor tilth runs together and seals over when wet. When dry this poor tilth soil dries out into clods nearly as hard as concrete.

d. Excess salts. Our semiarid Colorado soils have not been leached of their mineral plant nutrients as have the soils in the humid regions. In fact, in some places inorganic salts are in superabundance resulting in saline or "salty" soils. Because of the excess salts the plant roots cannot draw in moisture from the soil and therefore cannot survive.

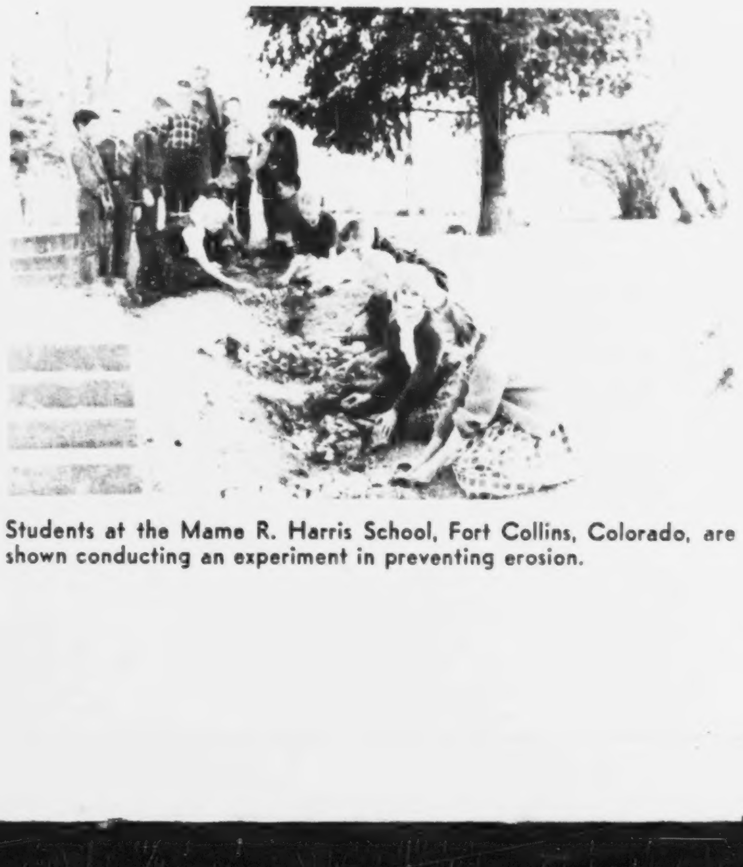
e. Soil organic matter and soil humus. The soil organic matter is made up of both living and dead plant roots, bits of leaves, twigs and bodies of bacteria, insects and worms. When the soil organic matter is rotted and partially decomposed it becomes humus. The bulk of the humus is made up of carbon, oxygen, hydrogen and nitrogen. Grouped together these elements form the carbohydrates, proteins and the fats in soil organic matter and humus.

2. Find samples of the above kinds of soils. Plant radish seeds in all soils. Make a productivity graph for each sample and compare.

**Proper conservation of soil directly affects all people, regardless of occupation.**

Activities

1. Discuss the economic effects of good and bad crops. Weather has the greatest influence on crops, but poor soil can reduce yield.
2. Find out how many city dwellers depend on one acre of soil for food. How will population expansion affect available food supply? Discuss current U. S. food surpluses, farm price supports and production limits.
3. Plant several seeds in a large box. Apply ammonium nitrate fertilizer to one half of box. Discuss value of fertilizing soil.
4. Prepare a bulletin board display illustrating the oxygen-nitrogen cycle. Discuss values of leaving plant residue on soil.



**Students at the Mame R. Harris School, Fort Collins, Colorado, are shown conducting an experiment in preventing erosion.**

5. Show pictures of wind and water erosion. Make a list of causes and remedies. One remedy for gully erosion was instituted by the Ft. Morgan Junior Conservation Club. Each year after Christmas, club members collect discarded Christmas trees and pile them in eroded gullies in the area. The trees absorb water, and replenish the minerals in the soil making it possible for grasses to grow and provide shelter for wildlife.
6. Discuss how soil conservation in the watershed as a whole and on the farm helps to prevent floods and loss of topsoil. Soil must be able to support plant life or it is useless. Discuss ways in which man destroys soil capabilities—forest fires, stripping of forest lands, overworking of farm soils, overgrazing, lack of irrigation or improper irrigation, leaching of important minerals, etc.

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### Films and Filmstrips

(Films and filmstrips without sources listed will be found in the *Mountain Plain Film Library Association Joint Catalog* 62-64)

*Birth of the Soil,* 10 min.

*Conservation Road,* 19 min.

*Return to Eden,* 15 min., color

See your local soil conservation office about films and talks.

## Vocabulary

acidity
aeration
afforestation
agriculture
alkaline

alkalinity
archaeologist
arid
back furrow
bacteriology

boron
break over
citrus
cobalt
contour

cover crop
crop rotation
dead furrow
delta
denuded land

dike
drought
enzyme
erosion
fertilizer

fingerling
foliage
forage
geophysics
geothermal

glacial till
grassed waterways
gravel
guano
gully

herbicide
hormone
humus
hydraulic
hydroponics

inorganic
insecticide
irrigation
land use map
leach

leaching
legume
lichen
loam
mesquite

microscopic
mulch
nitrogen
nodule
oasis

organic
overgrazing
phosphate
photosynthesis
potash

reclamation
reforestation
residual soil
rill
saline soil

salinity
scythe
sediment
shelterbelt
silt

sod
strip cropping
stubble mulching
subsoil
superphosphate

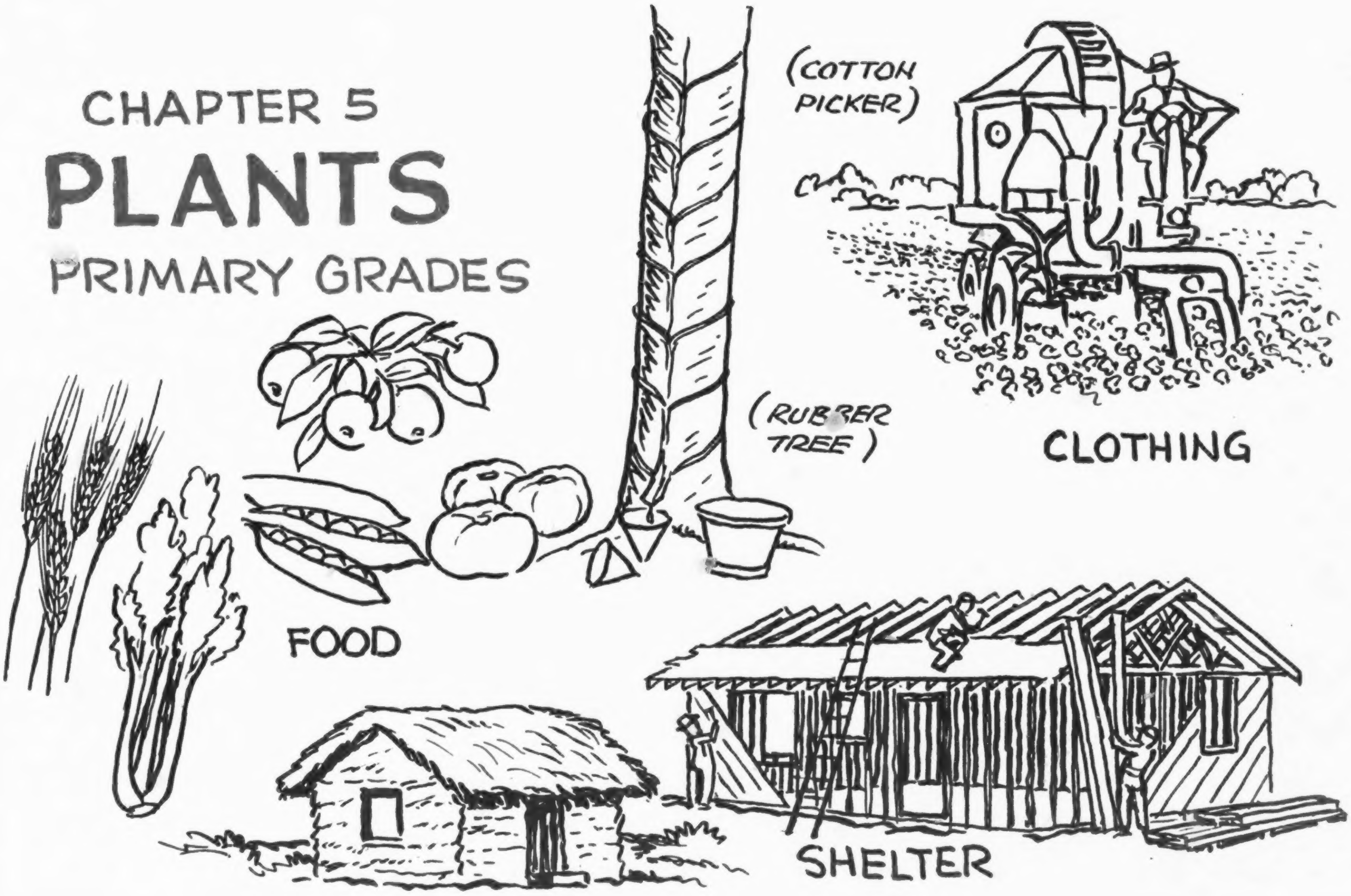
swale
terracing
tillage
topsoil
trace elements

vetch
watershed
weathering
wet lands
windbreak

# CHAPTER 5

# PLANTS

## PRIMARY GRADES



## Introduction

Plants constitute a renewable resource which provides food, clothing and shelter for animals and man. Through the process of photosynthesis, plants manufacture starches and proteins for their own sustenance and the sustenance of animals. Plants, in the form of farm crops, are a direct source of man's food supply and a source of food for the animals which supply meat.

Plants are important to all animals as providers of shelter. The beaver, for example, fells trees and builds a dam and lodge. The dam becomes a haven for fish and other animals and prevents water from leaving the watershed too rapidly and destroying wildlife, soil and crops in lower elevations.

Man, too, has always needed plants for shelter. Primitive societies use primary materials such as thatch and bamboo for building houses. Modern societies have advanced from using bare logs for cabins to pulverizing wood to make wallboard, and from hand-hewing rustic benches to machining rocking chairs.

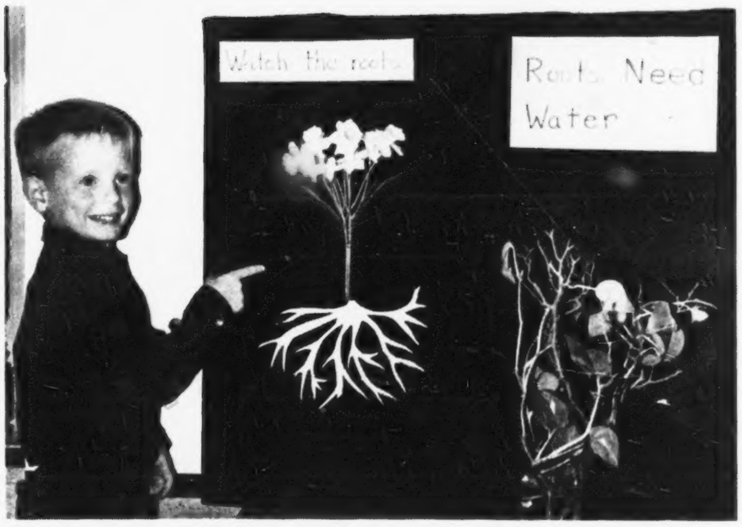
Man must be careful to conserve the plant resource in all possible ways. Plants need soil and water for growth and cannot go in search of them. If man is careless about the use of soil and consumes water too rapidly he will find that crops will no longer sustain him. The simple fact to be learned is that if man destroys forests and crops wilfully or through negligence he will be destroying his own position in the delicate balance of nature.

Plants are also valuable for their natural beauty. Massive forests, fields of wildflowers, parks and formal gardens help man to appreciate and enjoy the beauties of nature, beauties too often lacking in an urbanized culture. The immobile plant should also make man realize his responsibilities as guardian of all natural resources.

**Plants originate from seeds.**

Activities

1. Collect several kinds of seed. Moisten sponges and place a different kind of seed on each sponge. Set sponges in saucers of water. Observe differences in form as seeds sprout and grow.
2. Have children look around room or out the window to locate and describe all the different kinds of plants they can see—grass, trees, flowers, weeds. Compile a list of all the plants they eat and discuss in what forms various plants are eaten—roots, stems, fruit. Prepare a bulletin board showing a variety of plants and their functions.
3. To demonstrate how plants grow from seeds (germination), soak lima bean seeds overnight. Have children break seeds open and observe baby plant. Plant whole seeds, water and keep in light. Observe stem and leaves above ground and roots beneath the ground.
4. To demonstrate how some plants that were started



**Exhibits in the kindergarten at Mark Twain School, Colorado Springs, show (above) the importance of a root system and (below) the need for sunshine by plants.**

Needed Sunshine

from seeds can grow from other forms:

   a. Plant narcissus, hyacinth or tulip bulbs. Observe stem growing in one direction and roots in the other. The stem will always seek the source of light.
   b. Plant cuttings from geranium plants. Place in water until roots grow. Examine roots in detail and then plant in soil.
   c. Plant roots of plants that were started from seeds.
   d. Graft branches. Branches from one tree may sometimes be grafted successfully onto other trees.
5. Seeds are spread by wind, birds, animals and insects.

**Different plants grow in different places.**

Activities

1. Take children on walk around school grounds or neighborhood, observing the variety of plants. Make a list of tall plants, short plants, vines, bushes, trees, flowers, grass, etc.
2. Collect leaves from different trees. Have children bring leaves from home, the mountains and recreation areas.
3. Take children to a farm or collect pictures of farm plants.
4. To demonstrate that plants live in different environments:
   a. Place water plant (elodea, duckweed, etc.) in jar of water. Put land plant in another jar of water. The water plant will thrive, but the land plant will die because it is not adapted to extracting the necessary oxygen from the water.
   b. Find pictures of those trees and plants hardy enough to grow out of rocks where there is apparently no soil. Compare with plants such as corn and grains which need rich soil.

**Plants need food, water, light and space to grow.**

Activities

1. Grow radish, bean or corn plants in two containers for about one week. Stop watering one. Plants in the dry container will soon die.
2. Grow plants in two separate containers. Water both but keep one in dark closet, one in sunlight. The plant in the dark will yellow and die.
3. Grow ten or more plants in one very small container and one plant in another container. Observe that ten plants crowd each other and do not grow as tall as a single plant. Discuss reasons for this (more food, water and air for the single plant).
4. Put young plant near a window. Observe how plant grows toward sunlight. Turn plant away and observe how it will turn itself back toward sunlight.
5. Discuss effects of lack of water on crops. Total lack will kill crops, limited supply will limit size and yield of crops. The farmer depends on the water supply to help nature in providing for plants.

**Plants change with changes in season.**

Activities

1. Discuss plant transformations according to season:
   a. Spring. Seeds are planted, plants from bulbs begin to sprout and bloom. Trees begin to bud, blossoms on fruit trees appear.
   b. Summer. Baby plants have grown, flowers are blooming. Trees have full foliage, fruit on trees begins to be evident.
   c. Autumn. Plants such as corn, grain, garden vegetables are ready for harvest, fruit on trees is ready to be picked. With less sun and less direct sunlight leaves on trees begin to change colors.
   d. Winter. Annual plants die, perennials are dormant, and leaves fall off trees. Trees and bushes grow slowly in winter (branches expand).
2. Create conditions approximating cycle of seasons.
   a. Plant and care for seeds until plants are well above ground.
   b. Observe change in color from lighter to darker green as plant matures.
   c. Take plant away from sun and decrease amount of water.
   d. Freeze plant, observe decay.
3. In autumn gather several varieties of seed pods and examine the means provided for their dispersal—wind, water, animals, humans and birds. Emphasize the importance of leaving buds or blooms on flowers, trees and bushes. The blooms produce the seeds which ensure survival of the species.

4. Have children press the different colored autumn leaves. Place leaves between wax paper and press with hot iron. Study the color change.

**Plants carry on the processes of life anchored in one place.**

Activities

1. Plant a seed and observe its development, growth, maturity and decay. Discuss movement of plant in one place. Compare life cycle of plants to life cycle of migratory animals.
2. Draw a cross section of a plant, label each part and discuss its function.
   a. Root—provides food, water and support.
   b. Stem—transports food and water and provides support.
   c. Leaves—manufacture food.
3. To demonstrate how water moves to leaves place a piece of celery in half a glass of colored water. Observe upward movement of water.

**Plants and animals depend on each other for survival.**

Activities

1. Have children list all plant materials which they are touching—wood from trees, clothing from cotton, etc. List other ways in which humans and other animals are dependent upon plants, notably for food and shelter.
2. Take a piece of fluffy cotton. Pull away a little bit and begin twisting until a thin, smooth thread is spun. Consider how long it would take for one person to spin by hand enough thread for one dress or shirt. Stress importance of taking good care of clothes so they will last longer.
3. Show how different parts of plants can be used as food.
   a. Seeds—ground into flour; in pods (peas, beans, nuts).
   b. Roots—boiled (beets, onions, potatoes); raw (carrots, radishes, etc.).
   c. Stems—rhubarb, celery.
   d. Leaves—lettuce, cabbage, spinach.
   e. Fruit—cucumbers, peaches, watermelon, etc.
4. Prepare a bulletin board showing a composite plant with each part usable as food.
5. Make paper by boiling very fine sawdust from a sander. Add a little library paste, drain, pour in a rectangular mold and smooth. Discuss other writing surfaces such as papyrus, animal skin, stone.
6. Compare cross section of carrot with cross section of log. Observe similarities in structure. Discuss plants as a building material. What other plants are used as a building material besides wood? Thatch, grass, bamboo.
7. Plant several carrot seeds. After stalks are a few inches above ground, demonstrate how man can carelessly kill plants:
   a. By cutting off water supply.
   b. By polluting air and water (add salt water).
   c. By burning stalks.

   Compare man's destruction of trees in earlier years with that of modern forestry and management.

**Giant sunflowers which mature in four months were used to demonstrate plant growth to these kindergarten children at Stratton Meadows School, Colorado Springs. The children had planted the seeds in paper cups and later transplanted the seedlings.**

8. Make a list of all animal species found in the vicinity of a beaver dam. Discuss how plants provide food and shelter for wildlife.

**Plants offer a great variety of natural beauty.**

Activities

1. Have children bring their favorite flowers to school. Identify and list the colors. Discuss differences in blossom and leaf formation.
2. In springtime build a garden or plant flowers in a flower box. Try to include flowers with different colors and odors.
3. Discuss ways in which trees are especially pleasing—with blossoms, during autumn when the leaves have turned, fir trees covered with snow, etc.
4. Examine a flower; locate developing seeds. Stress the importance of not picking flowers in order to maintain their beauty and to ensure dispersal of seeds.

**Favorable environment will speed nature's processes in early spring; this is called forcing.**

Activities

1. Bring into classroom branches from flowering bushes when flower buds are mature but have not opened.
2. Place in water in a large container in the sun.
3. Pinch off a bud, open and examine.
4. Watch other buds unfold in a few days, while those on bushes and trees remain closed.

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### Films and Filmstrips

(Films and filmstrips without sources listed will be found in the *Mountain Plain Film Library Association Joint Catalog* 62-64)

*How Trees Help Us.* 11 min.

*Learning About Seeds.* 11 min.

*What Plants Need for Growth.* 11 min.

### Other Aids

Two charts, "Forests and Trees of the United States" and "Growth of a Tree" (both 25"x35" in full color), are available free from the American Forest Products Industries, Inc., 1816 N. Street N.W., Washington, D.C.

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# PLANTS - Intermediate

### Plants have a definite structure, physiology and growth pattern.

ACTIVITIES

1. Plant lima bean seeds between layers of moist blotting paper. Observe germination process.
2. Soak some lima bean seeds thoroughly. Observe scar where seed was attached to the pod and the micropyle (small pore-like opening). Slip off seed coat. Study external features. Separate two halves of seed carefully, noting that each half is a seed leaf between which, and probably attached to one of them, the embryo plant may be seen. Find the part which will become the root and the two very small true leaves. A hand lens will be helpful here for seeing the veins in the little leaves.
3. On a walk around the school grounds observe the following:
   a. Leaves, roots and bark of trees of different ages.
   b. The number of growth rings observable on stumps (or cross sections) of trees of different sizes.
   c. Examples of young, mature and old trees. Compare with infancy, youth, maturity and old age in humans.
   d. Differences of physical characteristics between seedlings and older trees of the same species.
4. Observe and record growth activity of one tree (or group of trees) during school year. Make drawings for notebook of trees with green leaves, colored leaves, shedding leaves, bare branches, buds in spring, new leaves, flowers, seeds, trees in full leaf.
5. Study and compare examples of coniferous and deciduous trees.
6. Make a scrapbook containing leaves, twigs with buds, sketches (or pictures) of trees or plants, common and technical names, description of plants, habitat and special characteristics. Include trees or wild flowers native to area and native to Colorado.

### Plants, like boys and girls, need food, water, air and light.

ACTIVITIES

1. Explain process of photosynthesis. Plants manufacture food through this process.
2. Cover one attached leaf of a potted geranium plant completely with an envelope of black paper. Seal so no sunlight can get in. Let stand for four or five days. Remove the envelope. Test leaf for presence of starch. Compare with uncovered leaves.

Parks and wildlife areas can serve as laboratories for the study of nature. In the photo above the class is helping the teacher place an identifying marker near a plant at the Jefferson County Outdoor Education Laboratory above Evergreen, Colorado.

3. Plant any kind of quickly germinating seed in two containers, one which contains good, fertile soil, the other poor soil. Keep light, air and water the same for each. Note differences in germination and growth rate. Sketch typical plant—its water supply, minerals, air exchange in photosynthesis.
4. To demonstrate that plants need the proper amount of water, take three plants, water one each day, stop watering the second completely, and immerse the third in water. Observe effects on each plant.
5. Add commercial fertilizer to a growing plant. Observe increase in growth rate.

### Plants reproduce and disperse their seeds.

Activities

1. Examine the flowers of several species of trees and plants. Observe reproductive parts. Label and learn the function of each part.
2. Observe activity of bees in spring around fruit trees and flowers. Discuss pollenization in detail (self pollenization, cross pollenization). Discuss hay fever.
3. Examine several seeds and observe their adaptations for dispersal. Seeds are carried by birds, animals, running water, wind, people. Make a report of the flora of the Hawaiian Islands or other islands. Are all plants native?
4. Examine small area of a field. Chart plant population. Determine kinds of plants and from where and how plants came.

### Plants are important in the formation of soil.

Activities

1. Prepare a bulletin board showing the natural cycle of soil formation.
2. Observe nodules of nitrogen-fixing bacteria on roots of large alfalfa plant. Discuss importance of nitrogen in stimulating plant growth.
3. Take a field trip to examine soil profile in a newly cut place. Observe humus, topsoil, subsoil, bedrock. Examine humus for unassimilated plant matter.
4. Prepare an experimental compost pile at a spot on school grounds. Use compost to reclaim poor soil.
5. Study loss of soil by erosion. Discuss importance of plants in preventing erosion. Plants (grass, bushes, trees) absorb water and slow runoff from rain and snow, thus preventing floods.
6. Plant two plants of the same species, in the same size containers, using identical soil. Put two or three earthworms in one container. Expose to same growing conditions. Observe noticeable difference in rate of growth. Compare function of earthworm to function of plants in the formation of soil.

### The climate and physical characteristics of the land affect growth and distribution of plant life.

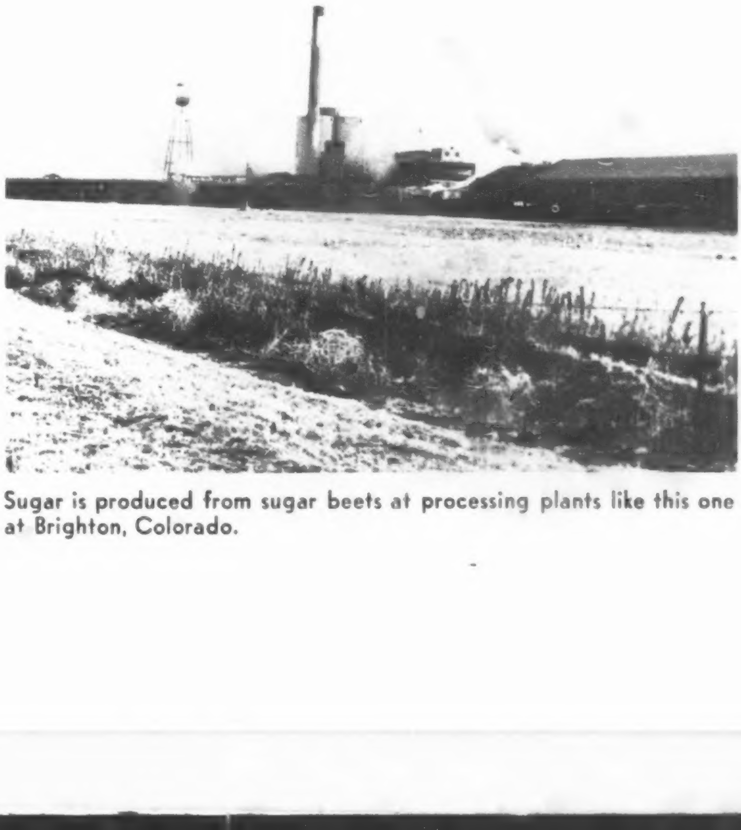
Activities

1. Prepare a bulletin board to illustrate life zones. Include drawings of typical plants of desert, forest, tundra and prairie.
2. Compare differences in plant communities of East Coast, Midwest, Rocky Mountains, Northwest and Southwest. What plants grow in all regions (grass, deciduous trees)? What plants are unique to an area (palm trees, cactus)?
3. Make a chart and map of plant life zones in Colorado. Observe plants and animals in your area.
4. Discuss adaptability, the ability to adjust to the environment. Compare land plants and water plants: each has adapted to the conditions of its own environment and could not survive in another environment.
5. Define timberline and discuss how conditions are favorable only to those plants which can survive in severe weather conditions. List plants which can survive above timberline. How does atmosphere affect species which do not normally grow above timberline but have strayed there (dwarfing)?

### Plants provide food, shelter, clothing and many other useful things.

Activities

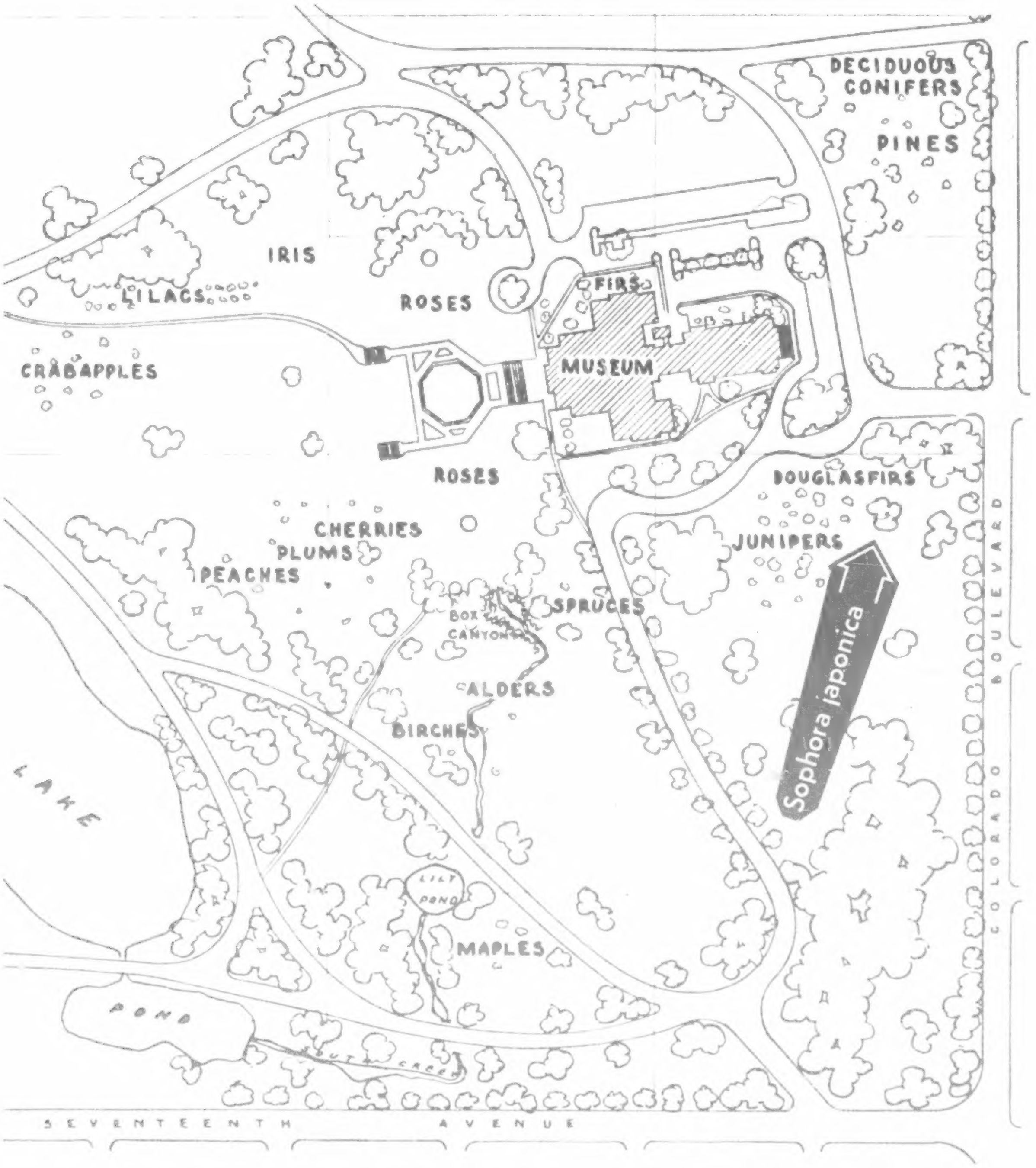
1. Have students list all the things they can see or touch which are made from plants.
2. Make a chart of a representative tree, listing all products which are derived from trees.



Sugar is produced from sugar beets at processing plants like this one at Brighton, Colorado.

# DENVER BOTANIC GARDENS

## *City Park Unit*


DECIDUOUS CONIFERS
PINES
IRIS
LILACS
ROSES
FIRS
CRABAPPLES
MUSEUM
ROSES
DOUGLASFIRS
CHERRIES
PLUMS
JUNIPERS
PEACHES
SPRUCES
BOX CANYON
Sophora japonica
ALDERS
BIRCHES
LAKE
LILY POND
MAPLES
POND
CREEK
SEVENTEENTH AVENUE
COLORADO BOULEVARD

The map above shows the City Park unit of the Denver Botanic Gardens. Two fine specimens of a Japanese pagoda tree (Sophora Japonica) will be seen there.

3. Draw a composite vegetable with, for example, carrot roots, celery stem, lettuce leaves, apples and walnuts.
4. Have students make research reports on the making of rayon; the uses of cotton stalks, corn husks, etc.; the plywood industry; impregnated woods, veneers, etc.
5. Study George Washington Carver's work on plants and especially the development and utilization of the peanut.
6. Write the following headings across the top of the chalkboard: saw logs, stumps, slabwood, sawdust and chips, pulpwood, sap, gums and resins, bark, fruits and nuts, roots. Starting with the first item, have each pupil in class list one product derived from saw logs. Continue in rotation for all items until students have listed all items they can think of.
7. Discuss the importance of plant life as a source of beauty and enjoyment.
   a. Collect *pictures* of mountain flowers. Wildflowers should not be picked in order to ensure their survival and to maintain their beauty for all to enjoy.
   b. List recreational opportunities provided by national parks and forests.

**A forest is an interdependent community of plants and animals.**

ACTIVITIES

1. Make a study of the layers of a forest, listing all plants

and animals inhabiting each layer (earthworms, grass, insects, ground animals, bushes, trees, birds, etc.).

2. Discuss the *symbiotic* relationship of plants and animals in a beaver pond area. Trees provide material for beaver dams and shelters. Dams support fish and provide water storage for animals and plants.
3. Show pictures of an area destroyed by fire. What life, if any, remains in the once thriving forest community? How long will it take for the forest to rejuvenate? Discuss the far-reaching effects of a forest fire, and stress the importance of fire prevention.

**With proper management, problems of preventing erosion and increasing land capabilities will be solved.**

ACTIVITIES

1. To demonstrate ability of covered soil to absorb water:
   a. Put a handful of bare soil in a glass. Pour in water and shake. Soil will mix with water and then rapidly sink to bottom as silt.
   b. Place a small clump of grass-covered soil in a glass. Pour in water and shake. Grass will absorb water and prevent soil from washing away from roots.
2. After a rainstorm observe the following:
   a. Grass holding moisture.
   b. Erosion where rapidity of water has washed away soil cover and soil (especially near drainpipes).
   c. Water dripping slowly from plants and trees, allowing soil more time to absorb water.
3. Assign individual research projects on the following methods of forest conservation:
   a. Reforestation.
   b. Modern logging and cutting methods in forests.
   c. Grazing permits and activities.
   d. Overgrazing of range land.
   e. Insect and disease control.
   f. Governmental agencies and groups engaged in range and forest management.
   g. Hunting and fishing rights.
   h. Multiple use of forest lands.
4. Organize a tree planting program in order to beautify the school grounds and community and to prevent erosion. Grass might also be planted on school grounds where erosion is noticeable.
5. Find an eroded area on school grounds and build a small dam to slow water runoff. Show pictures of areas where fill dams have successfully retarded erosion. Discuss TVA and other water control projects.
6. Visit a farm and observe measures taken to prevent erosion—contour plowing, strip cropping, planting of grass on fallow land, etc. Make a complete list of causes and remedies.
7. Visit Denver Botanic Gardens at Ninth Ave. and York St. or City Park. Note patterns of planting and some rare species such as the Japanese pagoda treet (Sophora Japonica).

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(Films and filmstrips without sources listed will be found in the *Mountain Plain Film Library Association Joint Catalog* 62-64)

*Adventures of Jr. Raindrop,* 8 min.

*Arctic Borderlands in Winter,* 10 min.

*Birth of the Soil,* 10 min.

*Everyman's Empire,* 18 min.

*Flowers, Fruits and Seeds,* 427-11, Row Peterson Plant Study Series.

*Forest Conservation,* 11 min.

*Forest Grows,* 11 min.

*Forest Produces,* 11 min.

*From Trees to Lumber,* 14 min.

*From Trees to Paper,* 13 min.

*Growth of Seeds,* 13 min.

*How Flowering Plants Reproduce.* Row Peterson Basic Nature

*How Green Plants Make and Use Food,* 11 min.
Study Series, 464-10.

*How Man Destroys Soil.* Row Peterson Basic Nature Study Series, 464-10.

*How Plants Help Us,* 12 min.

*How Plants Reproduce,* 10 min.

*How Seeds Are Scattered,* 11 min.

*It's a Tree County,* 14 min.

*Leaves,* 11 min.

*Life of a Plant,* 11 min.

*Life of Plants,* 10 min.

*Once Upon a Time,* 10 min.

*Partnership Among Plants and Animals,* 10 min.

*Plant Factories,* 427-12, Row Peterson Plant Study Series, 1347 Diversey Parkway, Chicago 14, Illinois, or the Society for Visual Education.

*Plant Growth,* 11 min.

*Plant Life at Work,* 11 min.

*Return to Eden,* 15 min.

*Save the Soil,* 11 min.

*Seed Dispersers,* 11 min.

*Seeds and Seed Travels,* 427-9, Row Peterson Plant Study Series.

*Seeds Grow Into Plants,* 11 min.

*Smoke Jumpers,* 10 min.

*Then It Happened,* 11 min.

*Wonders of Plant Growth,* 10 min.

### Other Aids

The following four charts are available from the American Forest Products Industries, Inc., 1816 N. Street, N.W., Washington 6, D.C.

"Forests and Trees of the United States" (25"x35" full color). "Growth of a Tree." "Help Them Grow" (17"x22" full color). "Products of the Tree Farm" (22"x34" full color).

A poster "The Tree and the Soil" (21"x16") is available from the U. S. Department of Agriculture, Forest Service and Soil Conservation Service, Washington, D.C.

Free or inexpensive materials and catalogs may be obtained from the following firms or agencies. (Note: It is best, in ordering free materials, to use school letterhead stationery.)

Allis-Chalmers Manufacturing Co.
Tractor Group
Milwaukee 1, Wisconsin

American Forest Products Industries, Inc.
1816 N. Street, N.W.
Washington 6, D.C.
(Bibliography of Teaching Aids 1961-62)

American National Cattleman's Assn.
Director of Information
801 East 17th Street
Denver 18, Colorado

Bureau of Communication Research, Inc.
National Board of Fire Underwriters
465 California Street
San Francisco, California

Educators' Guide to Free Films
Educators' Progress Service
Randolph, Wisconsin

Modern Talking Picture Service
28 E. 9th Avenue
Denver 3, Colorado

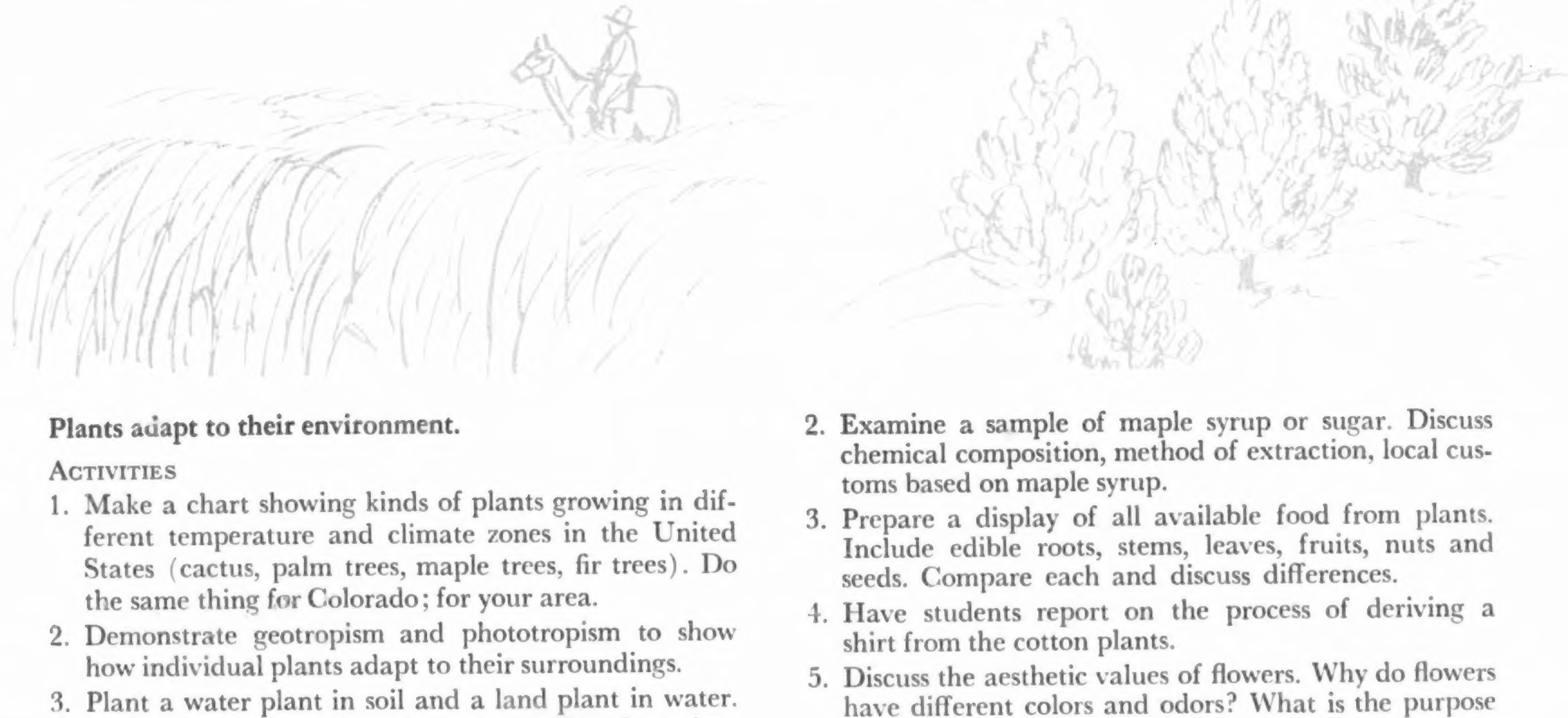
United States Department of Agriculture
Forest Service
Washington 25, D.C.
("Materials to Help Teach Forest Conservation" K-28)

U. S. Department of Agriculture
Soil Conservation Service
Washington 25, D.C.
(or nearest soil conservation district)

U. S. Forest Service
Visual Aids Section
Colorado State University
Fort Collins, Colorado

Weyerhaeuser Company
Film Service, Dept. of Public Information
Tacoma Building
Tacoma, Washington

# PLANTS - *Junior High*



**Plants adapt to their environment.**

ACTIVITIES

1. Make a chart showing kinds of plants growing in different temperature and climate zones in the United States (cactus, palm trees, maple trees, fir trees). Do the same thing for Colorado; for your area.
2. Demonstrate geotropism and phototropism to show how individual plants adapt to their surroundings.
3. Plant a water plant in soil and a land plant in water. Observe growth or decay. Discuss specific adaptations of each plant to its environment ($O_2$-$CO_2$ cycle, etc.).
4. Compare soils of a mountain area with those of a short-grass area for:
   a. Soil profile.
   b. Amount of humus.
   c. Amount of macroscopic soil organisms.
   d. Water-holding capacity of rocks of various size grades (sand, fine gravel, coarse gravel, rock).

**Plants provide food, shelter and clothing.**

ACTIVITIES

1. Prepare a bulletin board showing all products derived from trees (lumber, paper, turpentine, fruit, etc.).
2. Examine a sample of maple syrup or sugar. Discuss chemical composition, method of extraction, local customs based on maple syrup.
3. Prepare a display of all available food from plants. Include edible roots, stems, leaves, fruits, nuts and seeds. Compare each and discuss differences.
4. Have students report on the process of deriving a shirt from the cotton plants.
5. Discuss the aesthetic values of flowers. Why do flowers have different colors and odors? What is the purpose of flowers on plants?
6. Show pictures of a burned-out area or a crop destroyed by floods, hail or wind. Discuss the effects of plant destruction on farmer, marketer and consumer. Review fire prevention and soil conservation procedures.

**Grasses and legumes are important in everyday life.**

ACTIVITIES

1. Bring into class a healthy specimen of alfalfa or clover and study the root system for nodules. Open one of the nodules and make a microscopic slide of the bacteria present.
2. Diagram the nitrogen cycle to show the importance of legumes in conserving and replacing nitrates in the soil.

3. Determine the value of grass to animals and in soil conservation.
   a. Leaf growth from near ground level.
   b. Extensive root system to absorb water and hold soil.
   c. Ability to store food in leaves and stem as well as in roots.

**Societies throughout the world are influenced by the kinds of plants that can be grown and by man's management and use of the plants.**

ACTIVITIES

1. Determine how plants have influenced the types of housing used by various cultures (log cabins, bamboo houses, thatch huts, etc.).
2. Compare the cultures of China and the U.S.A. and their principal food crops.
3. Make a study of the forestry practices employed by Germany and the United States. Does the German Forest Reserve Plan limit forest use too much?
4. Make a study of the peoples of a desert area, an arctic area and a tropical area. Compare culture with the kinds of plants available, both natural and domesticated.
5. Visit nearby areas of natural vegetation. Colorado offers several types—grasslands, forests, and deserts. Even for urban areas these often are not far. Take a plant census. Look for signs of animals that live on the plants.
6. Visit nearby croplands. List the kinds of crops and their requirements. Discuss why the croplands are located as they are. Is it because of soil or water or both? See if any domestic animals are part of the cropland picture.
7. Finally, walk the sidewalks nearest to the school. Take a tree census here, noting exotic and native types. Consider the plants grown in the yards. Here there will also be evidences of animal life, even if it is only insects.

**Colorado's forests are valuable in industry, recreation, and water production.**

ACTIVITIES

1. Study the importance of forests in watershed control. The condition of the watershed affects the lumber industry, cattle and sheep industries, agriculture and urban areas.
2. Make a report on the lumber industry in Colorado. How extensive is it? Where and how are the products used?
3. Invite members of the U. S. Forest Service and the Colorado Game, Fish and Parks Department to discuss the problems of providing safe and enjoyable recreation in forest areas.
4. Have students write essays describing hunting, fishing and camping trips they have taken.
5. Study the National Park System and the U. S. Forest Service. Compare the Forest Service's multiple use policy with the National Park policy of complete preservation.
6. Prepare a radio or television script whose characters present various versions of use and value of the forests to a visitor from far away. Possible characters might include: a student from Point Barrow, Alaska, as the visitor, an early settler in Virginia, an early settler in eastern Colorado, a National Forest Service employee, a National Park Service employee, a Game, Fish and Parks Department employee, a good citizen, a poor citizen, an old-time lumberman, his grandson, a modern-day lumberman, a farmer, and a Soil Conservation Service employee. By using "an employee," these parts are open to girls or boys; also this gives an opportunity for vocational guidance.
7. Colorado's forests are valuable in industry, recreation, and water production. Every effort should be made to preserve them.

**Proper management increases the productivity and value of forests and grasslands.**

ACTIVITIES

1. Find stories about "wars" between cattlemen and sheepherders. What was the basis for these conflicts? Is overgrazing still a problem today? Overgrazing, which can cause serious erosion by decreasing protective soil cover, can be controlled by not allowing too many stock animals in the area.
2. List the major destroyers of forests and learn how to combat them.
   a. Forest fires.
   b. Fungus. Show pictures or drawings of common fungi and their effects on trees. Are all fungi harmful?
   c. Insects and disease. Discuss the effect of the spruce bark beetle on the forest of Colorado. Find out how many board feet of standing timber has been killed, and determine the value of the losses. Learn the various methods of control and the relative effectiveness and efficiency of each. Discuss other important insects and diseases in Colorado, such as the dwarf mistletoe, mountain pine beetle, and the spruce budworm, and learn the methods of controlling each.
3. Investigate existing reforestation and tree planting programs in your area. How effective have they been? Can students take part in these programs?

**Local, state and federal laws directly affect forest management and conservation.**

ACTIVITIES

1. Prepare reports on the various Homestead Acts, emphasizing how they have affected the forests and grasslands. What are some of the good and bad features of these acts?
2. Discuss the establishing of National Parks and National Forests. How do these help in the management of forests and grasslands?
3. Divide the class into groups and have each group investigate the needs of a particular forest user—lumberman, hunter, housing developer, etc. Have each group present the reasons why it should be allowed to use the forests. After each group has presented its case, discuss and plan a compromise which would allow everyone to use the forests satisfactorily. Discuss the U. S. Forest Service's multiple use plan for national forests.
4. Make a study of all local, state and federal laws and taxes which regulate or may affect the use of forests and grasslands. Are these laws consistent with the multiple use concepts, and do federal, state, and local taxes encourage proper land management?

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———. *Teachers' Manual.* Washington: the Industries. This provides a study outline and lists learning experiences through which forestry may be integrated into several subject matter areas from grades 4 to 12.

———. *Why We Must Have Multiple Use Forest Management.* Washington: the Industries. A 24-page booklet for the teacher which presents the current forest resource picture in the United States and discusses rising future needs for wood products and outdoor recreation in the face of growing losses of forest land to other uses. Defines multiple use forest management, and shows how it holds the most promise of meeting increasing needs for wood, water, recreation, wildlife and forage.

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### Films and Filmstrips

(Films and filmstrips without sources listed will be found in the *Mountain Plain Film Library Association Joint Catalog* 62-64)

*Birth of the Soil.* 10 min.
*Bounty of the Forest.* 28 min.
*The Forest.* 28 min.
*From Trees to Lumber.* 14 min.
*From Trees to Paper.* 13 min.
*A Heritage We Guard.* 30 min.
*It's a Tree Country.* 13½ min.
*A Strand Breaks.* 15 min.
*Strands Grow.* 15 min.
*A Tree Is Born.* U. S. Forest Service.
*Understanding Our Earth, Soil.* 10 min.
*What Is Soil.* 10 min.

### Other Aids

The following charts and posters are available without charge from the American Forest Products Industries, Inc., 1816 N. Street, N.W., Washington, D.C.:

"Forests and Trees of the United States" (25"x35", full color). "Growth of a Tree" (25"x34", full color). "Help Them Grow" (17"x22", full color fire prevention poster). "Products of a Tree Farm" (22"x34", full color).

### Vocabulary

aphid
backfire
beachcomber
beam
beetle

blight
block cutting
chaparral
coniferous
cross pollenization

deciduous
deciduous forest
DDT
distillation products
domestic

epidemic
erosion
fauna
firebreak
fire line

fire tower
flora
fungus
gang saw
germinate

girdle
hybrid
incendiary
infrared
jeep

kiln
laminated
larvae
lignite
mattock

pigment
pine tar
plexiglass
prelogging
plywood

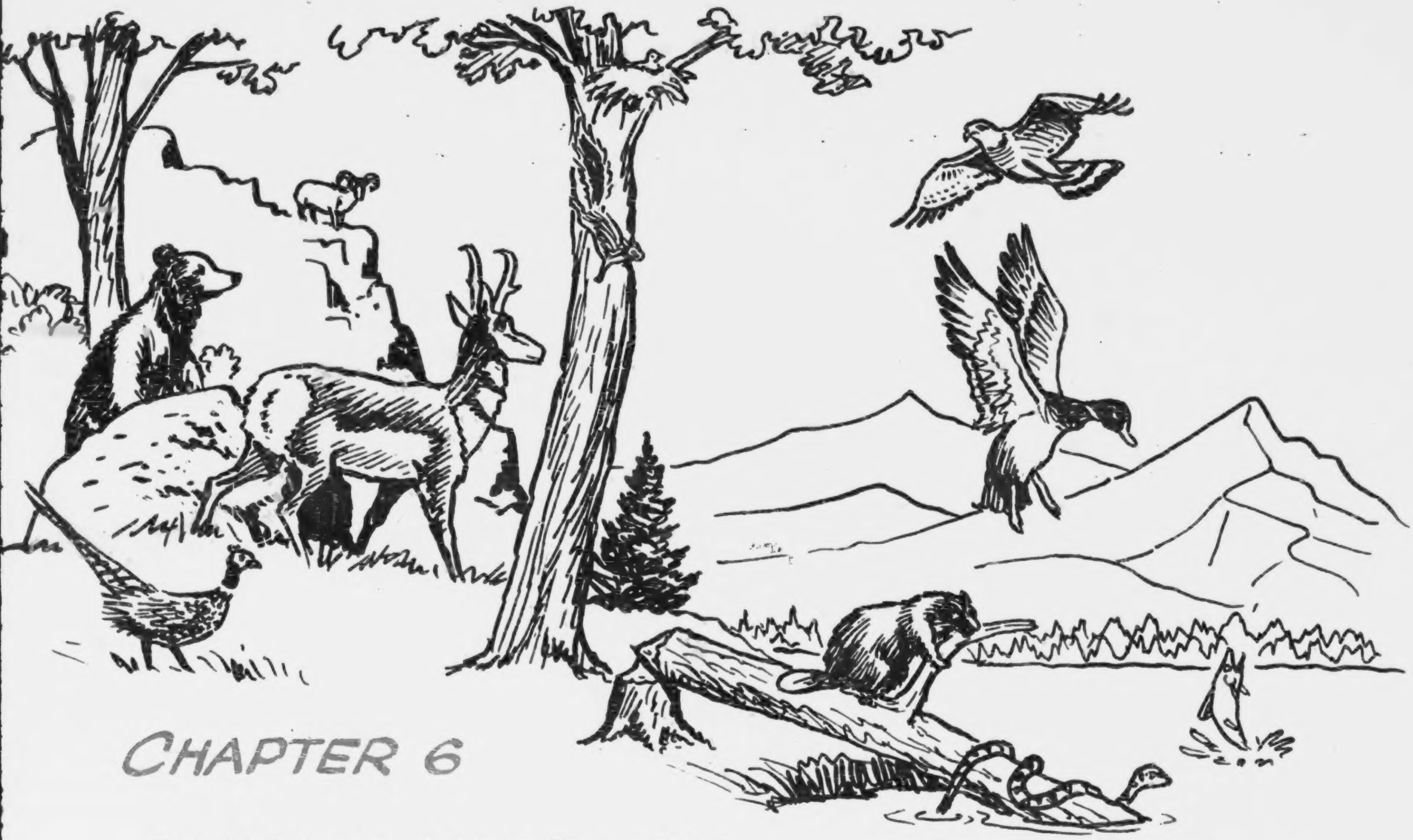
pulpwood
reforestation
relogging
resin
Rocky Mountain forest

rodent
rosin
rotor
scarified
seedling

selective cutting
serum
shelter belt
Southern forest
spore

sustained yield
tannic acid
thinning
transplant
tropical forest

turpentine
veneer
vertebrae
watershed
windbreak



## CHAPTER 6

# ANIMAL WILDLIFE *Primary Grades*

### Introduction

The unprecedented growth of America from a foundling country to a major world power was possible primarily because of vast natural resources. In the process of growing, however, our precocious country has been guilty of flagrant misuse and inexcusable exploitation of these natural resources. One such misused resource is our wildlife.

Man has depended in varying degrees upon wildlife throughout the history of his development. In the early days of his existence the animals in his environment provided food, clothing and shelter. Some species were enemies to be feared, other forms were useless to him, but there is little excuse for the wanton slaughter and waste so characteristic of "modern civilized man."

Wildlife populations have always increased and decreased in cycles influenced by changes in the environment. Man has necessarily had to change the environment in the process of settling the country, and for a long time many people felt that wildlife was to be sacrificed on the altar of progress. We are only now beginning to realize that man can farm the land, harvest the timber, raise domestic livestock, build roads, construct buildings and still provide proper habitat to nurture wildlife through a conscientious and cooperative effort.

The key to the problem of wildlife conservation is proper management. It has been said that wildlife management is primarily a problem of human management and education, but wildlife management has become a very technical field and as in other fields of study the more we learn the more there is to know.

In Colorado, the responsibility for wildlife management rests with the Department of Game, Fish and Parks. The Department's field men, known as Wildlife Conservation Officers, enforce conservation laws and protect wildlife from avoidable destruction. Their duties are also to inform the public about wildlife protection, and they are usually available to speak to groups about wildlife conservation and management.

If the program of wildlife conservation is to be successful, each member of the populace must be informed of the problems that exist and must act intelligently to solve them.

**There are many kinds and sizes of animals.**

ACTIVITIES

1. Have children list domestic and wild animals.
2. Bring a pet to school and talk about physical characteristics of animals. Discuss how animals are similar to man.
3. Collect insects and observe activities. Discuss whether insects are harmful or beneficial.
4. Display snakes and discuss their functions.
5. Discuss polar region and desert animals. Refer to pictures showing contrast between these types.
6. Take a field trip to a zoo or farm to observe variety of animals. Have children make a list of large and

small animals, those with horns or tusks, and those with distinctive coloration.

7. Tell stories in which animals are the main characters.

**Animal habitats are adapted to the environment.**

Activities

1. Prepare a bulletin with sections labeled Mountains, Plains and Water. Have children post pictures they have drawn of animals inhabiting each environment.
2. Find a bird nest and discuss characteristics of materials, shape, size, etc. Explain how nests are designed to protect small birds from weather, predators and gravity.
3. Show pictures of a prairie dog village to illustrate an animal community similar to a human community. Discuss mound-building, food-gathering, protection system, etc.
4. Make a list of the kinds of animal habitat and animal homes within a square block of your school. Include domestic animals, and animals which live above and below ground and in the water.

**Birds are animals which are adapted to flight.**

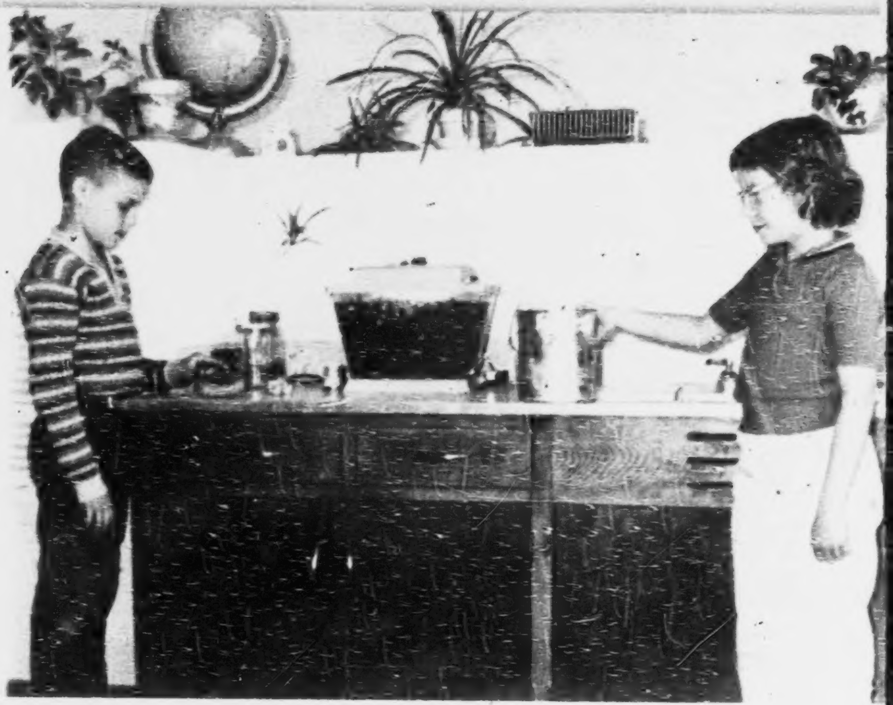
Activities

1. Show pictures of the skeleton of a bird, a bear (or dog) and a man. Locate the limbs and digits on each.
2. Observe birds in flight. Some birds flap their wings continually, some soar and glide.
3. Explain why birds can land on 'hot" wires. Emphasize why man must be careful of all electrical wires.
4. Make a list of the colors of common birds—robins, bluebirds, canary, blackbird. Show pictures of parrots and discuss reasons for bird coloration.
5. Discuss the ways in which birds are beneficial to man.
   - a. Eating insects and small animals which are harmful to crops.
   - b. Providing cheerful song.
   - c. Food—chickens, ducks, turkeys, etc.

**Fish are important in maintaining the balance of nature in supplying food and recreation for man.**

Activities

1. Prepare an aquarium with clean water, clean gravel, plants and fish. Seal aquarium tightly and observe how fish and plants can exist without an outside source of oxygen (oxygen and carbon dioxide cycle).
2. List kinds of fish found in Colorado waters (warm water fish and cold water fish). List salt water fish and other seafood.
3. Have children describe fishing trips they have been on. Discuss fishing regulations which limit size and amount of catch. Demonstrate the skill of fishing.
4. Discuss commercial and domestic importance of Colorado mountain trout as food.



**A balanced aquarium is both interesting and educational to young people.**

**Hunting is important in Colorado for recreation.**

Activities

1. List the kinds of animals that can be hunted.
   - a. Small game—rabbit, pheasant, quail, duck, geese, turkey, etc.
   - b. Big game—deer, elk, antelope, sheep, bear.
2. Prepare a bulletin board showing simple safety procedures for hunting trips. Include gun safety and survival instructions (children should never leave camp alone).
3. Discuss how game animals can be harmful to man.
   - a. Damage to crops by deer and elk.
   - b. Attacks by enraged animals.
   - c. Blocking highways and causing automobile accidents.

**Wildlife management protects animals from extinction and maintains wildlife populations at a desirable level.**

Activities

1. Contact Colorado Game, Fish and Parks Department or local sporting goods outlet for copies of *Big Game Hunting Regulations* and *Small Game Hunting Regulations*. Study game maps and key to determine which areas have the most liberal bag limits and therefore the largest game population.
2. Discuss benefits of game management and population control. Overpopulation cuts down the amount of food available to each animal, makes him less able to withstand winter weather, and causes him to compete with domestic livestock for food. "Harvesting" of excess population improves chances for survival of the species and provides recreation.
3. Make a list of animals protected by law—mountain goat, buffalo, cranes, canvasback and redhead ducks, etc.
4. Invite a wildlife conservation officer from the Game, Fish and Parks Department to explain management techniques.

# Colorado Squirrels

The rodents (Rodentia) are one of the most diverse orders of American mammals. Represented here are only seven of the scores of forms, only two of the twenty-odd main rodent groups, and only one of the eight rodent families—the *Sciuridae* or squirrels, limited to tree and ground living species. Prairie dogs and woodchucks are excluded. There seem to be no flying squirrels here.

## TREE SQUIRRELS

The *pine* or *spruce* squirrel is the best known bushy-tail in Colorado since it is an inhabitant of coniferous forests, exclusive of pinon-juniper. Spruce, at 10,000 feet, it its most typical cover. Excitable and pugnacious, pine squirrels squawk at robin or hunter on occasion, lie low on another. In the end, though, curiosity gets the best of him and out he comes.

The *fox* is Colorado's largest squirrel, an invader from the East via the wooded South Platte, Republican and Arkansas Rivers. It is restricted to cottonwood bottoms and windbreaks and to some east-slope towns.

*Tassel-eared* or *Abert's* squirrels, in both the gray and black ("melanistic") phases, are more or less limited to the yellow (ponderosa) pine zone, mainly in the southwest and along the Front Range. Tassel-ears are only slightly smaller than fox squirrels.

## GROUND SQUIRRELS

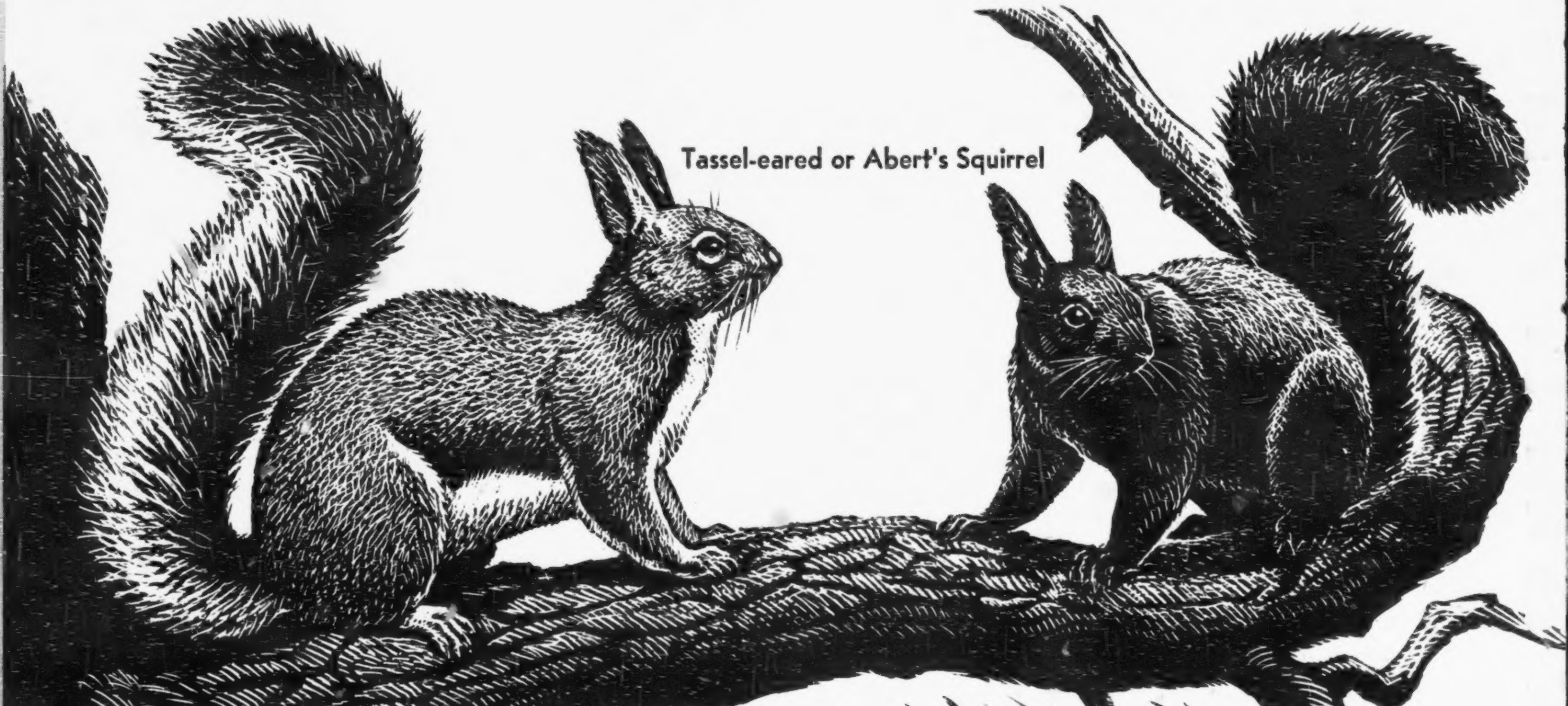
Of the dozen or so ground-living squirrels in Colorado, only four are mentioned here. They represent two divisions, the ground squirrels proper and that favorite of people afield, the chipmunk.

Of the first group, the rock squirrel is the largest and brownest; the *Wyoming* or *picket pin* is the smallest and grayest; and the *Say's* or *golden-mantled,* in between in size and with a broad, whitish, side stripe, looks more like an over-grown "chippy" than like its nearer relatives. This squirrel finds its way into almost every camp in the woods. The *chipmunk,* of which there are at least four Colorado species, is the smallest squirrel in the state.

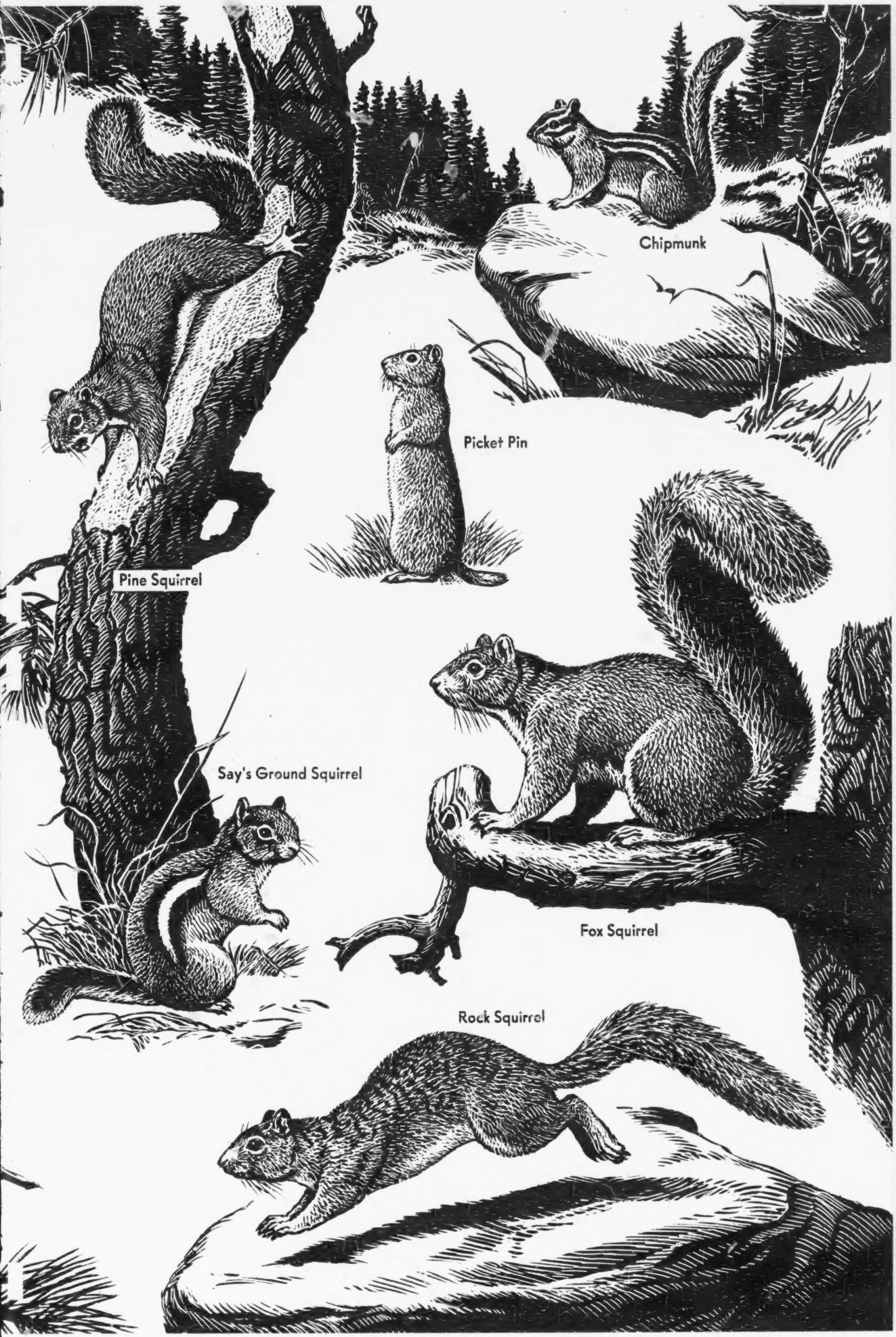
As to habitat, the rock squirrel lives mainly in arid, rocky brushland; the picket-pin on grass-sagebrush plains and the drier mountain meadows; the Say's is a woods and brushland form; and the chipmunk, another forest dweller, is most common around small mountain parks, especially where there is a variety of weeds, grasses, and berry bushes.

While running, the Say's holds its tail at roof-top angle; the "chippy's" stands straight up. That's why boys call 'em "low-tailers" and "high-tailers," respectively.

Lee E. Yaeger



**Tassel-eared or Abert's Squirrel**


Chipmunk
Picket Pin
Pine Squirrel
Say's Ground Squirrel
Fox Squirrel
Rock Squirrel

**Birds need help in getting food when the ground is covered with snow.**

ACTIVITIES

1. Birds like seeds, crumbs, and suet cakes.
2. Discuss where to place the food to protect the birds from animals.
3. Make a bird feeder.

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(Films and filmstrips without sources listed will be found in the *Mountain Plain Film Library Association Joint Catalog* 62-64)

*Adventures of Two Little Goats.* 10 min.

*Adventuring Pups.* 10 min

*Animals at Work in Nature.* 10 min.

*Animals in Autumn.* 10 min.

*Animals in Spring.* 10 min.

*Birds of the Dooryard.* 10 min.

*Farmyard Babies.* 10 min.

*Fluffy, the Ostrich.* 10 min.

*The Frog.* 11 min.

*Gray Squirrel* 11 min.

*How Animals Defend Themselves.* 10 min.

*How Birds Help Us.* 10 min.

*Life in a Fishing Village.* 10 min.

*Monarch Butterfly Story.* 10 min.

*Mother Rabbit's Family.* 10 min.

*Muzzle Shy.* 10 min. Game, Fish and Parks Department, State of Colorado.

*Plant Life at Work.* 11 min.

*Robin Redbreast* 11 min.

*Spider Engineers.* 12 min.

*Three Little Bruins in the Woods.* 10 min.

*We Explore the Woodland.* 10 min.

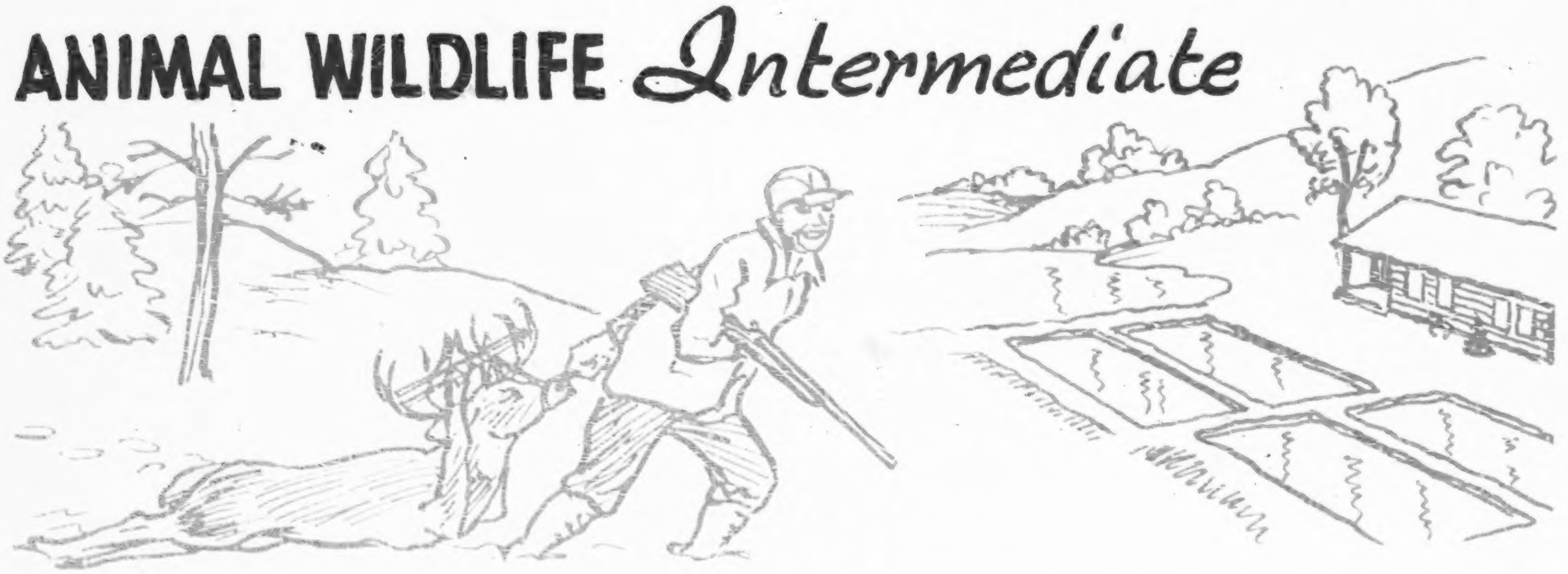
*Wildlife of Desert.* 11 min.

*Woodpecker Gets Ready for Winter.* 9 min.

### Other Aids

See list of films available free from the Colorado Department of Game, Fish and Parks as listed under Wildlife—Junior High.

# ANIMAL WILDLIFE *Intermediate*



**Hunting today is the harvesting of a man-managed crop, which will soon cease to exist if we *do not* aid nature in its continual production.**

Activities

1. Collect pictures of Colorado wildlife that are allowed to be hunted.
2. Discuss hunting laws and regulations, striving to understand the necessity for them.
3. Make charts showing the approximate numbers of different species maintained by the state.

**The mortality of many wild species may be as high as 80 percent yearly.**

Activities

1. Let each child choose a wild animal on which to read and report the mortality rate.
2. Have the children tell about the many causes of mortality.
3. Read a story about natural enemies.

**Both cold water and warm water fish are important to Colorado sportsmen.**

Activities

1. Use physical maps of Colorado to locate places where cold and warm water fishes are found (consider elevation).
2. Have children relate their own fishing experiences and decide whether warm or cold water fishes were involved.
3. During some periods of the year children may bring specimens of fish they have caught.
4. Take a trip to a hatchery or have a child report on a visit.
5. Make individual booklets with both categories.

**Some fish are canned commercially, e.g., salmon, tuna, etc.**

Activities

1. Make an exhibit of emptied containers of different kinds of fishes. Connect these to a large world map posted behind. (See sketch.)
2. Ask your school nurse to talk to your class about the nutritional value of fish.
3. Good films have been produced by processors of tuna and salmon.
4. Discuss the anadromous characteristics of salmon, and the necessity to protect spawning.

**Most fish lay eggs and hatch young; some fish, however, give birth to live fish.**

Activities

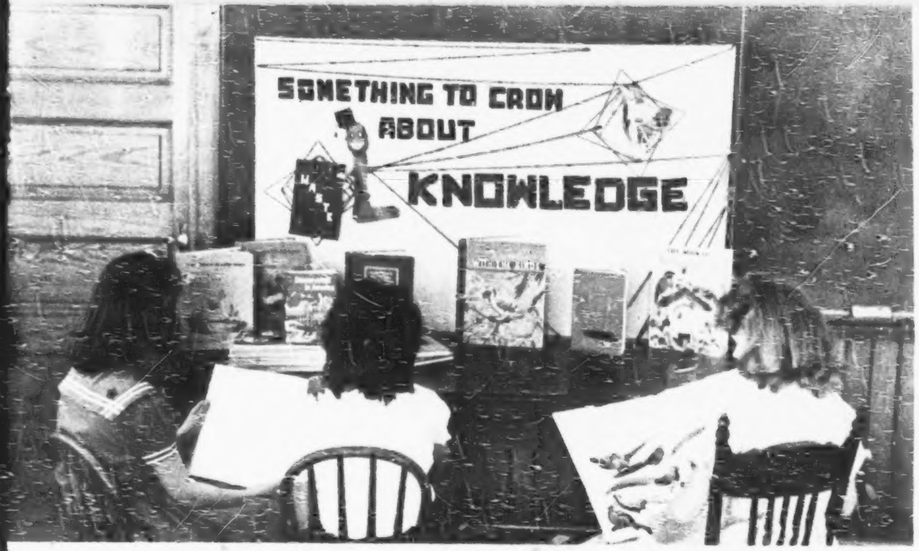
1. Let children observe over a period of time guppy reproduction in an aquarium or large jar.
2. Try to hatch live fish eggs in the classroom. If these are not available, uncolored salmon eggs can be shown.
3. Ask an appropriate resource person to speak on this subject.

**Some fish and even aquatic mammals live on microscopic plants and animals. Others live upon the young of their own or other species.**

Activities

1. Enlist the help of school science personnel to tell about aquatic organisms.
2. Make microscopic slides of minute aquatic life taken from a nearby pond, lake or river.
3. To catch fish the bait must match the diet of the fish at feeding time.

This attractive marine exhibit was made at Remington School in Fort Collins, Colorado.



As part of a class project at Remington School, Fort Collins, Colorado, these students set up this reading center which contains materials pertinent to the topic they were studying.

4. Use the bioscope or micro-projector to show water life that is difficult to be seen by the naked eye.
5. There is also competitive life in the ocean. Homes can contribute for an exhibit.

**Birds are more mobile than other animals because of their adaptation to flying. Many birds migrate with seasonal changes.**

Activities

1. Have small groups research the different flyways and report on them.
2. Make large maps of each flyway.
3. Draw up a list of migratory and non-migratory birds seen locally.
4. Collect and display pictures of birds.

**Each bird species prefers certain climates and certain temperature, moisture and vegetation.**

Activities

1. Look up how to build bird houses in encyclopedias, scout handbooks and other books.
2. Construct bird feeder stations and bird houses according to specifications.
3. Make habitat dioramas of several species.
4. Discuss the adaptation of the English sparrow to our country.
5. Have children make models of birds from clay, soap and other materials.

**Hunting is a major recreational activity in Colorado.**

Activities

1. Arrange to have a father tell of his hunting adventures. Ask him to explain safety rules in hunting, and hunter safety.
2. Send out a class-made questionnaire to find out the kinds of hunting done by parents.
3. Have a sporting goods representative explain equipment and licenses needed for hunting.
4. Have a man from the Game, Fish and Parks Department in your area explain license to hunt and the rights of the land owner. The Operation Respect program is especially interesting.
5. Make map overlays showing the kind of hunting done throughout the state.

VATION IS EVERY

This three dimensional soil display contributed to the effective teaching of a unit on conservation at Remington School, Fort Collins, Colorado.

6. Invite a Game, Fish and Parks Department representative to teach hunter safety to sixth grade.

**Animal population growth is largely determined by adequate food, water, cover and space.**

Activities

1. Take a field trip to a known habitat of small game. Have groups investigate the following requirements: food, water, cover and space. Hold a field critique and compare hypotheses drawn with what a local resident or conservation officer tells you.
2. Find out what is being done in your community to promote wild animal population management.
3. Build bird-watering stations.
4. Note how wildlife management is affected through harvesting timber, planting wildlife foods, controlled burning, shelter belts.

**Environmental factors are constantly operating on wild species to hold their numbers down (predators, disease, starvation, accidents, parasites and adverse weather).**

Activities

1. Using the factors as column headings, make charts of each Colorado small game specie.

Sixth grade boys at Palmer School in Denver made models of nine African animals in a proportion of one to three. The photo above shows how metal lath is formed over a strong wooden frame. Papier mache is plastered onto the lath and painted.

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# ANIMAL WILDLIFE *Junior High*

**A suitable environment for fish includes a balance between oxygen and carbon dioxide.**

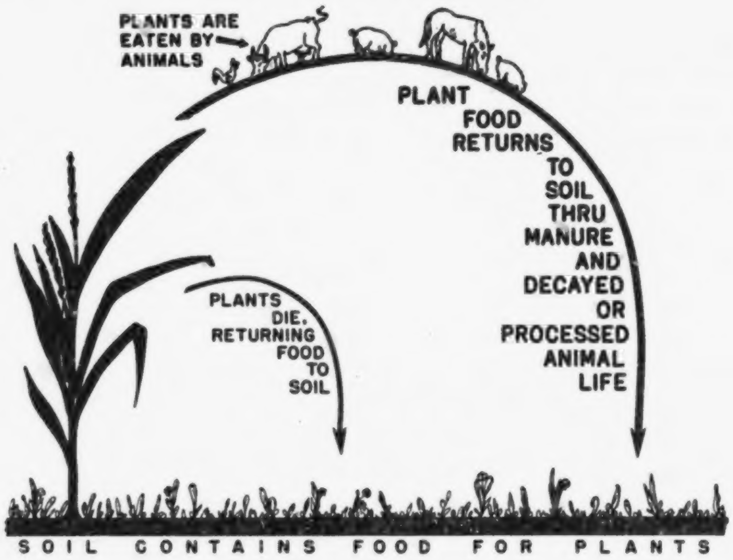
ACTIVITIES

1. Take a trip to a pond containing fish and one which does not support fish. What differences are noted in the plant life in each? In the animal life in each? What about the circulation of the water?
2. Prepare aquaria, one with plants and fish, the other with only fish; compare fish life in two jars, one with tap water, the other with boiled water. Study effects of using live food and prepared food. Many tests and experiments can be conducted here including silting effects, minerals present, types of aquatic plants, other animals in addition to fish, predator fish, etc.
3. Assign special reports:
   a. Why are aquatic plants necessary for a balance between oxygen and carbon dioxide in an environment suitable for fish?
   b. What might happen to this balance in a lake covered by ice for an abnormally long period?
   c. Discuss the respiration of fish. Where do they get their oxygen? How does it get in the water? How is it replenished? Can there be too many fish for the amount of oxygen present?

**Small game animals consist of birds, rabbits, squirrels and numerous fur bearing animals, i.e., beaver, martin, badger, and bobcat. Colorado is a good habitat for small game with its prairies, foothills, and mountains.**

ACTIVITIES

1. Discuss some of the important characteristics of the major fur bearers.
2. Discuss the role of the fur bearers of Colorado in the


PLANTS ARE EATEN BY ANIMALS
PLANT FOOD RETURNS TO SOIL THRU MANURE AND DECAYED OR PROCESSED ANIMAL LIFE
PLANTS DIE, RETURNING FOOD TO SOIL
SOIL CONTAINS FOOD FOR PLANTS

THE NATURAL CYCLE

settling of the West. Trappers often preceded explorers into the wilderness.

3. Discuss the importance of the wild fur bearers in our state at this present time. Why has there been a decline in the importance from earlier days?
4. Discuss the importance of the beaver in water conservation, flood control, fish production, etc.
5. Take a field trip to a pond or lake where either beaver or muskrat have homes. What seems to be their food supply? What else can be seen? Protection of lair?
6. Take a field trip to a local zoo to see these animals in real life or in their habitat at the State Museum of Natural History, Denver.
7. A representative of the Bureau of Sport Fisheries or the local W.C.O. (Wildlife Conservation Officer) could be invited to speak to the class on fur bearers. Pelts are used by some in their talks and many have slides to enrich their presentation.

**There is a relationship between wildlife production and number of young in a litter, number of litters per year, minimum and maximum breeding age, and breeding habits, i.e., monogamy and polygamy.**

Activities

1. What is meant by monogamy and polygamy?
2. Why is it important to protect the wildlife during mating and rearing seasons?
3. Discuss the passenger pigeon and the disastrous results from hunting during mating seasons and uncontrolled bag limits.
4. A research project on propogation, number of young per litter and rate of reproduction for various species of wildlife may be undertaken by a class. The information gained could be correlated to observations as to the number of animals in the wild seen by members of the class, length of hunting seasons, problems of management, etc.

**Species which are food for predators have more young than the predators; nature seems to provide.**

Activities

1. Do the number of animals which are the prey for predators control the number of predators or vice versa?
2. Name some of the animals which are prey for common predators such as fox, bobcat, coyote, and mountain lion. How do the numbers of young compare with the numbers of young of the predator animals? Compare rabbits and coyotes, mice and shrew, mountain lion and deer or small game.
3. What are some evidences of cycles in animal populations? Are these caused by number of predators; what other factors may be involved? What animals are cyclic?
4. What is meant by breeding potential?
5. Using reference material prepare a chart for predator animals and animals preyed upon; include this information:
   a. Number of young per litter.
   b. Number of litters per year.
   c. Age when animal first reproduces.
   d. Average length of life.
   e. Is the species prey or predator?

**Fishing is good, wholesome recreation. Both cold and warm water species are growing in demand as our population increases.**

Activities

1. Discuss the recreational values of fishing for persons who because of age or other factors are somewhat limited in activity.
2. Discuss the importance of fishing as a form of relaxation in wandering along a stream and communing with nature.
3. What are some of the problems in maintaining sufficient numbers of fish to meet the growing demands? What are some possible solutions?
4. List warm and cold water species; include food needs and habitat requirements.
5. A project with the local W.C.O. (Wildlife Conservation Officer) or other wildlife officer involving planting of fish, seining, rearing or some other facet of fish management would be helpful here to illustrate some of the problems involved in providing fish for the fisherman. Take a trip to the local fish hatchery.
6. Determine approximate amount of money spent in your area in fishing; include equipment, lodging, food, travel, etc.
7. A research study on economic value of commercial fisheries in the United States would make a good special report.

**The objective of game management is to produce sustained yields of game and fish for recreational uses.**

Activities

1. Discuss what would happen to yields of game and fish if all management and restrictions were lifted.
2. Discuss examples of wildlife either extinct or nearly so because of inadequate management.
3. With the help of the local W.C.O. (Wildlife Conservation Officer) study the organization and functions of the Department of Game, Fish and Parks for Colorado. This study should include financing, delegation

of responsibilities, management areas, educational programs, etc.

4. A field trip to a local fish hatchery or wildlife preserve will show some of the problems involved in producing game and fish for recreation.
5. Take a survey of people in your community or parents of the class to determine the number of people who have as a major form of recreation either fishing or hunting or both. What is their estimate as to the amount spent on these two sports? What type of fishing is the most popular in your locality, warm or cold water fishing? Does the locality influence this?

**Some fur bearing animals are trapped in season for their pelts.**

Activities

1. Discuss the role of fur trading for pioneer people and compare with fur trappers today.
2. List the fur bearing animals in your locality. If the area is suited for trapping some of the boys may want to start a small trap line during the season. Some may have had trap lines previously and could relate some of the experiences connected with it.
3. Research into the annual income from trapping would indicate the economic importance of the fur bearers today in the state and nation.

**Small game hunting seasons are established for rabbits, ducks, doves, and other small game.**

Activities

1. List some factors which regulate the establishing of hunting seasons.
2. Determine some reasons why an annual harvest is important.
3. Using regulations and maps printed by the Game, Fish and Parks Department determine why some species are hunted in one area and not in another, why the seasons are of different length, and why they vary from one year to another. What has happened during the past year in your locality which might affect the hunting seasons? How will it affect them, favorably or unfavorably?
4. List the small game animals which can be found in your area. How does this list differ from a nearby area, from a distant area and from another state? Why?

**The hunting of big game supplies recreational opportunities and brings millions of dollars annually to help our state's economy.**

Activities

1. Name some kinds of business that receive this income, i.e., licenses, equipment, lodging, etc.
2. Discuss the number of jobs made possible because of big game hunting in the state.
3. Contact the chambers of commerce to determine the values of big game hunting in your area. Take a survey of businesses to get approximate income from sportsmen. Figure the value in the meat taken at current livestock prices. How many people make their living directly or indirectly from big game hunting? This could include guides, outfitters, photographers, sporting goods stores, etc. Compile and summarize the information gained from the questionnaire and draw conclusions as to the importance of this sport to your community.

**Many people value the wildlife for their beauty in nature.**

Activities

1. Discuss with students some of the memorable experiences with wildlife that they have found. How have these experiences enriched their lives?
2. Have special reports from wildlife trips in Yellowstone National Park or other game refuges. Bring out the time to see wild game is at feeding time, evening or early morning.
3. Discuss some techniques of wildlife photography.
4. Some students may want to start a collection of personal photographs of wildlife, others may want to collect commercial wildlife photographs. A class photograph album can be kept including pictures taken on field trips.

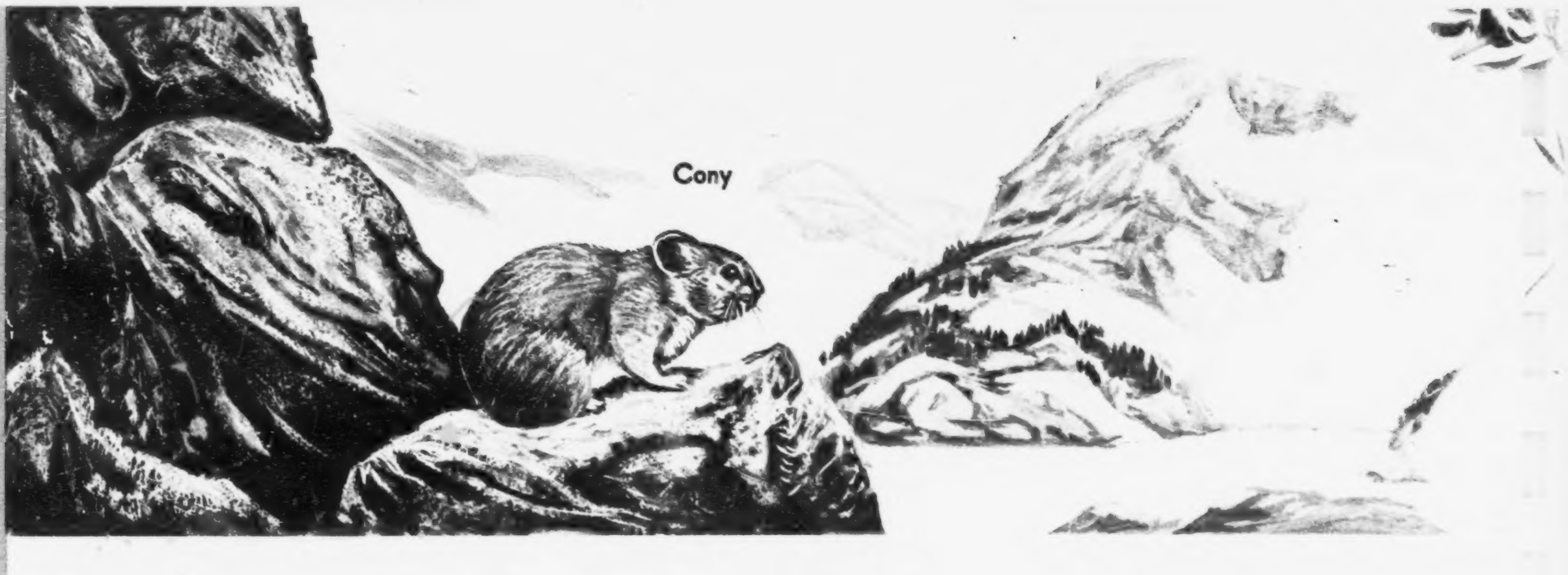
**This outstanding junior conservation club exhibit of wildlife is displayed in the corner of a classroom at Fort Morgan Junior High.**

5. Make a list of wildlife species in art and decoration, i.e., the American Eagle, the buffalo on a nickel, etc.
6. Study some of the work of wildlife artists such as Lyndle Dunn and others. How can their work be so realistic? They must be quite familiar with the wildlife. Have some of the students who are artistically inclined try their skill at drawing wildlife forms. A notebook containing drawings and information about each could be made.

**A successful management program depends on the help and cooperation of the public.**

Activities

1. Contact one of the groups or organizations of private



# Colorado Hares

Jack rabbits and snowshoes live in the open country and depend upon speed for safety from enemies. The cony and cottontail seek shelter and safety in holes, rocks, and brush.

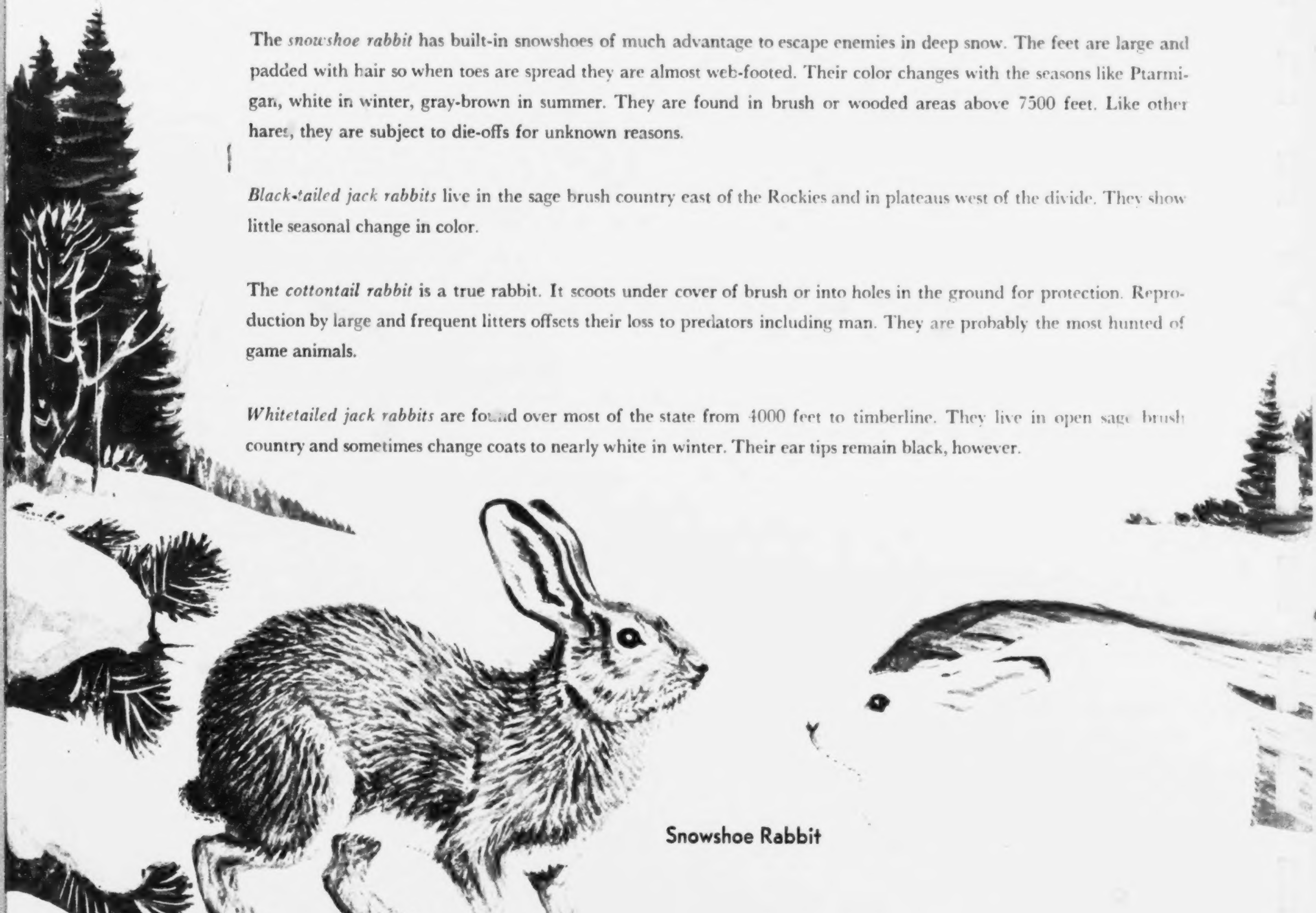
The *cony* (or pika) is found at high altitudes among the rocks. It issues a "squeekie" sound that is hard to locate. It follows a unique practice of curing and storing hay for winter food.

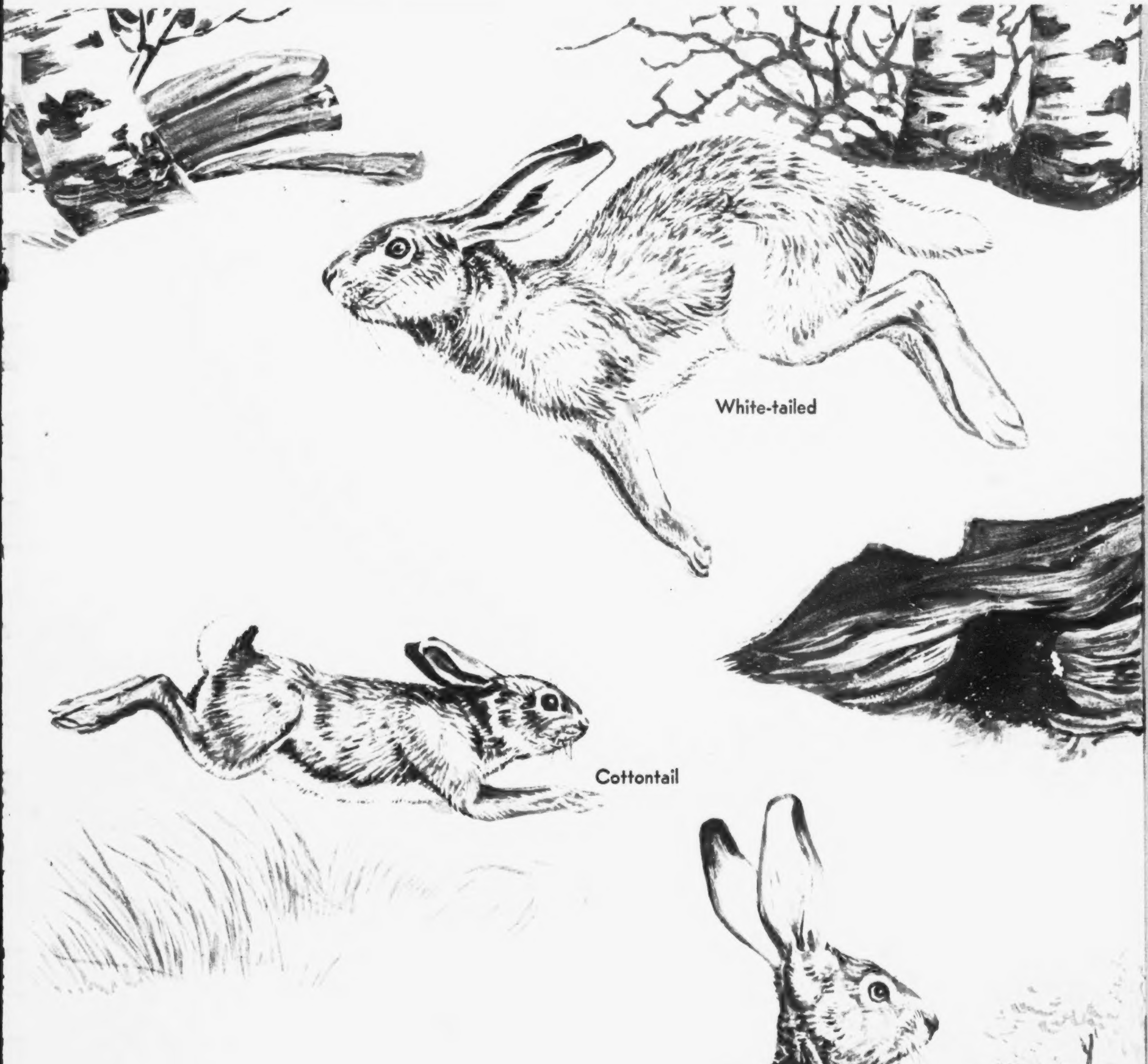
The *snowshoe rabbit* has built-in snowshoes of much advantage to escape enemies in deep snow. The feet are large and padded with hair so when toes are spread they are almost web-footed. Their color changes with the seasons like Ptarmigan, white in winter, gray-brown in summer. They are found in brush or wooded areas above 7500 feet. Like other hares, they are subject to die-offs for unknown reasons.

*Black-tailed jack rabbits* live in the sage brush country east of the Rockies and in plateaus west of the divide. They show little seasonal change in color.

The *cottontail rabbit* is a true rabbit. It scoots under cover of brush or into holes in the ground for protection. Reproduction by large and frequent litters offsets their loss to predators including man. They are probably the most hunted of game animals.

*Whitetailed jack rabbits* are found over most of the state from 4000 feet to timberline. They live in open sage brush country and sometimes change coats to nearly white in winter. Their ear tips remain black, however.




White-tailed
Cottontail
Blacktailed Jack Rabbit

citizens which work to promote wildlife conservation. Examples are Izaak Walton League and gun clubs.

2. Discuss the importance of education in proper wildlife management.
3. Make a list of the ways in which each person can help in the wildlife management programs of your area.
4. Students can make posters on various phases of wildlife conservation. The best can be used to display in local stores and businesses.
5. Groups of students can work with local civic groups engaged in conservation activities or plan their own activity with the help of the local wildlife conservation officer, i.e., planting trees for shelter areas, maintain feeding stations, plant aquatic plants for waterfowl, etc. There is a real need for a conservation club in many junior high schools.
6. Essays on the importance of wildlife conservation can be written and submitted in essay contests or printed in school papers. In addition, photographs of conservation activities can be printed in local newspapers. This will help bring conservation to the attention of the adults in the community. The conservation class might sponsor a conservation essay contest throughout the school.

**A license is required to hunt or fish in Colorado. The money is used for the management program.**

Activities

1. Discuss the importance of the income from the sale of licenses to the wildlife management program in the state.
2. What other purposes do license requirements serve?
3. Get copies of game and fish regulations. What are rules governing licenses? Why are young hunters and fishermen (under 15) permitted to take half of the daily bag limit of small game without having a license? Do you think that this is a good or bad practice? Why?

**Sportsmen must respect the property rights of landowners. Wild game belongs to the public, but this does not give anyone the right to hunt on privately-owned property; owner permission is necessary.**

Activities

1. In the fall collect and make a poster of news items which show poor sportsmanship.
2. Discuss the growing number of rod and gun clubs which lease private land for their own use. What are some of the advantages to this type of hunting, and what are some of the bad features?
3. Discuss examples of damage done by hunters on private land that the students have heard about.
4. Discuss the private hunting preserves. Is this a satisfactory solution to the problem of hunting areas? If there is one in your locality a person from the preserve might be invited to talk about this type of program.
5. On an extended trip through the country near your school, note the number of fields which are posted—compare with the number not posted. How many were posted with a sign reading "Hunting by permission only" or something similar? (This activity could be accomplished in conjunction with another field trip.)
6. Take a survey of local landowners to find out if they permit hunting and fishing. Have they had any property damage? Do they lease to private clubs? Are there specific things they would like to see done to improve the sportsman-landowner relationship? Perhaps the class can be of help.
7. Obtain material on Operation Respect (a landowner-sportsmen's club). Some of this material could be distributed to local landowners and to sportsmen interested in maintaining areas open for hunting and fishing. Get information from Colorado Game, Fish and Parks Department, 6060 Broadway, Denver 80216.

**Hunting seasons are arranged to harvest game crops according to population surveys. Some of the tools of management are: census checks, tagging and banding, aerial surveys, range surveys, hunting season data, manipulation of vegetative cover, and the construction of access roads.**

Activities

1. Invite a representative of the Game, Fish and Parks Department to come and talk on the various means of management. In conjunction with this, several projects may be undertaken to assist the local W.C.O. in his management program. Offer your help to him.
2. Obtain a big game map (printed every fall showing game management areas, lengths of seasons, bag limits, etc.). In groups determine why one section has a long season and another has a comparatively short one—why antlered animals only are taken in one area and either sex may be taken in another area. Discuss the results of the groups' discussion with the entire class. What observations can be made from this map?
3. A few of the boys may be able to work with the W.C.O. on game check stations or similar activities. If this is possible, have the individuals report to the class some of their observations.
4. Ask for individual reports on:
   a. What would happen if uncontrolled hunting were allowed in the state?
   b. Why does the hunting become poorer near the close of any season?
   c. Why is the harvest of male animals only often inadequate for game management?
   d. Why is the control of hunting and fishing in the hands of the state government? Why not private organizations?
   e. What federal controls are exerted on game management at the state level?

**Some animals are trapped and moved to more favorable areas or areas of less concentration.**

Activities

1. Discuss the trapping and moving of elk in Yellowstone National Park. Why is this necessary? What are some objectives of this program?
2. Discuss the practice of trapping and moving beaver from one locality to another. What are some of the reasons this is being done?
3. Do you think that the balance of nature is upset by this type of action? Is it favorable or unfavorable?
4. Invite the W.C.O. to visit class and discuss the procedures involved in trapping and moving game animals. View pictures of live traps. What animals could be moved from one area to your area and prosper?

5. A study of exotic animals that have been introduced in various areas should be made. Examples of transplants such as the pheasant which have been favorable and advantageous and others such as the English sparrow which have been much less favorable could be studied. Point out some of the problems which can arise from introducing animals not native (exotic) in a new area.

**Water pollution affects and limits growth of aquatic forms of life.**

ACTIVITIES

1. Discuss some examples of polluted streams in Colorado. What is polluting them, what effect has this had on the aquatic life of the stream? How might this be stopped?
2. Develop social responsibility around the question: Does any person or group of persons have the right to pollute water if it affects someone else?
3. Why does this pollution continue? Can legislation be passed regulating water pollution? Why aren't some of the laws which exist more strictly enforced?
4. Look up the laws governing river water in your community. Are they being violated? Whom can we thank for the purity of your water supply?
5. Conduct this activity which was suggested in the wildlife conservation guide for the State of Michigan.
   a. Obtain four large bottles (preferably of two gallon size). Place approximately two inches of sand in the bottom of each bottle. Plant the same number of water plants which may be obtained form any store which sells goldfish and aquarium supplies in each bottle, fill each bottle with water, place two fish in each bottle. Label the bottles one to four. In number one place a snail; in number two drop a slice of bread; in number three place 2 c.c. of toxic chemical such as tannic acid; in number four place a half pound of colloidal clay. Seal each bottle with a cork and sealing wax. Leave in sunlight. Do not disturb any of the bottles but the one containing colloidal clay. This bottle should be shaken slightly several times a day in order to keep the clay suspended. Observe the changes that take place in the color of the water in bottle number two. What caused the color to change? How were the fish affected? How does the control bottle number one differ from two, three, and four in the appearance of the plants and animals?
   b. Keep a record of what happens and the time of observation of the experiment.

**The drainage of wetlands has limited the production of waterfowl in many areas throughout the nation making it necessary to set aside preserves and sanctuaries where the waterfowl can nest and raise their young.**

ACTIVITIES

1. List the wildlife preserves throughout the country which are set aside for waterfowl. Are there any in Colorado? Where are most of them located? Locate on an outline map of U.S.A. the major flyways of waterfowl and compare with the location of the preserves.
2. Assign special reports on the following problems:
   a. Does this problem of drainage in Northern Canada affect the sportsmen in Colorado?
   b. What are some possible solutions to this problem of drainage?
   c. Since the migratory waterfowl are under federal control, and their migration covers the entire continent, what are some of the problems involved in proper management?
   d. What can be done here in Colorado? Are there any waterfowl which hatch and raise their young in our state?
3. Locate a landowner who doesn't allow hunting on his property, but wouldn't mind improving a pond or lake on his property to provide a nesting refuge. If such a place can be found, determine the conditions which are necessary for waterfowl to nest and improve the areas for this purpose, i.e., plant wild rice or other foods, build nesting boxes, etc. in the wildlife refuge.

Note: The Audubon Junior Club program has splendid materials for three kinds of clubs: Birds, Mammals, and Trees. A free booklet explaining the program can be obtained from National Audubon Society, 1130 Fifth Ave., New York City 10028.

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*Attracting Birds*, C.B.-1, 1947.

*Distribution of American Gallinaceous Game Birds*, C-34, 1955.

*Fishery Resources of the United States*, Senate Department 51, 1945.

*Fishes of the South Atlantic and Gulf Coasts,* C.B.-37, 1944.
*Food from the Sea—Fish and Shellfish of New England,* C.B.-33, 1943.
*Guarding Our Wildlife Resources,* C.I.A.-5, 1948.
*Homes for Birds,* C.B., 1942.
*Migration of Birds,* C-16.
*Principles of Game and Fish Management,* 1963.
*Some Common Birds Useful to the Farmer,* C.B.-18, 1942.
*This Is a Pondfish Hatchery,* C-40, 1946.
*This Is a Salmon Hatchery,* C-25, 1953.
*This Is a Trout Hatchery,* C-31, 1945.
*Wetlands of the U. S.,* C-39, 1956.
*Visit to a Federal Fish Hatchery,* A, C-25, 1953.

## Films and Filmstrips

The following films may be borrowed free from the Game, Fish and Parks Department, State of Colorado, 6060 Broadway, Denver, Colorado 80216.

*Beaver, The.* 10 min., color. Very excellent, seldom seen activities of our friend the beaver.

*Duck Hunter's Dilemma.* 22 min., color. Shows the Game and Fish Department attempting to restore breeding places for waterfowl. Shows how to reduce waste of useless shooting, counting eggs laid, and banding ducks.

*Fishing in the Clouds.* 13 min., color. One in a series of Game, Fish and Parks Department movies designed to interest the sportsmen; in this case, the fisherman. Exciting scenery above timberline.

*Forest in a Museum.* 11 min., color. Features the 1¼ acre "Beaver National Forest" exposition at Ghost Ranch Museum in New Mexico. Story of multiple use through small-scale models of animals, people and fire tower, and real trees, grass and water.

*Game Animals of Colorado.* 13½ min., color. Beautiful scenes taken in natural habitat—no hunting or shooting. Good at all levels. 1964.

*Game Birds of Colorado.* 13½ min., color. New 1964—beautiful scenes, no hunting or shooting. Good at all levels.

*Legends of the Ladore.* 18 min., color. The Ladore, accessible only by water, is a rarely visited canyon of the Green River in remote northwestern Colorado. Scenery beyond description.

*Prairie World of the Kit Fox.* 22 min., color. The story of the small prairie Kit Fox. Covers its life history. Shows environment, and delves into the general history of the predator species. Ecological study of life on the prairie.

*Realm of the Beaver.* 25 min., color. A beaver's place in the western United States. Follows the beaver through the history of the early West to today, and explains his importance.

## Other Aids

If you are near the Metropolitan Area, plan a trip to the Museum of Natural History where plants and animals can be seen in their natural habitat. Plan with children to study what is shown, not just look. Call the Museum for an appointment.

*Colorado Outdoors* (bi-monthly magazine), published by the Department of Game, Fish and Parks, State of Colorado, Denver, is very interesting.

The habitat groups at the Colorado Museum of Natural History in Denver City Park are the best to be found in the United States, especially for ecological studies.

## Vocabulary

algae
alkali
archaeologist
Audubon Society
biologist

buoy
burrow
carnivore
centigrade
cholesterol

chumming
crustacean
epidemic
erosion
exterminate

extinct
fauna
fertile
fingerling
flora

flyway
forage
fry
guano
habitat

harpoon
hatch
herbivore
humus
hydroponics

illegal
incubator
insecticides
irrigation
kelp

larvae
levee
marsupial
migration
monogamous

naturalist
natural resources
nurture
nutrition
overgrazing

pelagic
pelt
photosynthesis
plankton
poaching

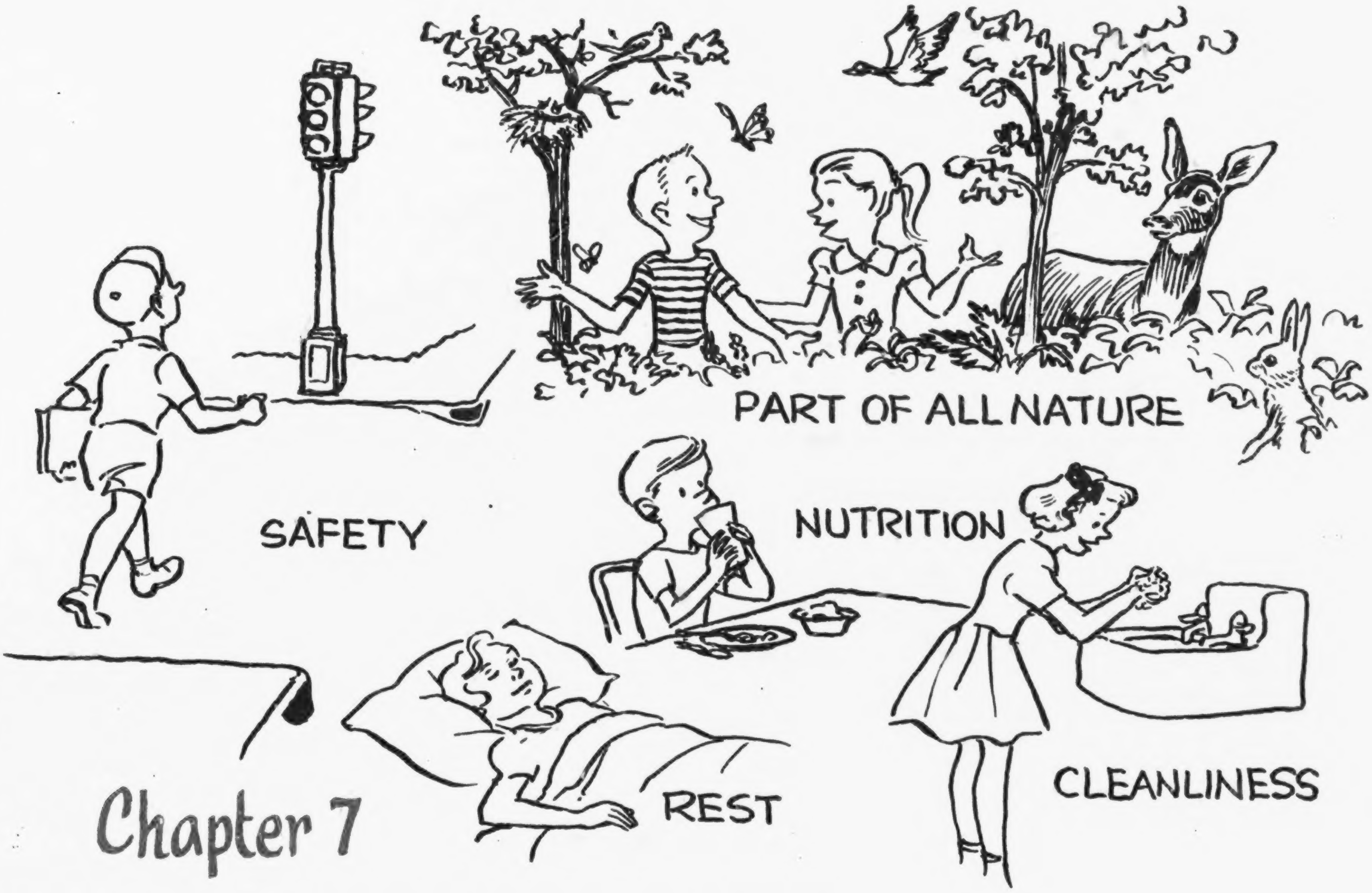
pollution
riboflavin
sanctuary
sewage
silt

skiff
snare
sonar
spawn
species

spillway
strip mining
technology
trajectory
trophy

tsetse fly
vitamins
waterfowl
watershed
wildlife refuge

winch



# Chapter 7

# HUMAN RESOURCES - *Primary Grades*

## Introduction

The essence of all conservation practices is found in the program of the education of the youth of our nation, for until the individual learns to realize his own full potential he will never see the need of an effective program of conservation of all other natural resources.

Man must realize that he is a part of nature and depends upon all natural resources for his life. He must learn to identify himself as a resource which can be conserved or exploited, and he must assume the responsibility of using all resources wisely in order to maintain life in the present and the future.

Boys and girls are the most important resource in nature. Each child has the potential to be of value in the world, but too often he does not learn the responsibility and self-respect which will help him realize his potential. We read in the headlines, "Crime Increasing, Youth Physically Unfit, School Dropouts Increase, Vandals Damage Picnic Area," and many other examples of an individual's failure to understand his place in nature and society.

While a child is still in school, the teacher has the opportunity of teaching him the skill of self-evaluation, the ability of developing his potential, and the necessity of exercising his powers of choice in a rational manner. The teacher will be considered a "conservation expert" if he provides concrete motives for developing: pride in the child's school, city and county, self-respect, respect for others, and a responsibility to use all natural resources wisely.

"Vandalism," "littering," are both expressions in direct opposition to the conservation way of life. The true test of good teaching can be found in the behavior of pupils, their attitudes and actions, their responsibleness and dependability. If what they learn does not affect these qualities, the knowledge can be of little value. The principal of a school holds the key to behavior within his building. School spirit, patriotism, and respect for decency can all grow out of a well-planned community non-litter campaign. Teachers can tie this spirit with conservation activities according to the child's maturity, thus developing the most important natural resource, that of *humans*.

Teaching self-determination belongs to no specific level of instruction. In the primary level, students should be introduced to the idea of self-determination. The idea is developed in the intermediate grades, and in the junior and senior high schools, students should be capable of practicing self-determination, of making their bodies respond to their intellectual choices.

**The human resource is of a physical, intellectual and social nature.**

Activities

1. Have children demonstrate walking, running, jumping, throwing, etc. Discuss why exercise is necessary to maintain health.
2. Explain the processes of thinking and reasoning.
   a. Have a child tell about crossing a street.
   b. Have him tell when it is safe to cross and when dangerous.
   c. Explain to the child that he first thought about an action and then by reasoning decided how to act.
3. Have children define a "group." Show how the actions of each member affect the whole group or society. Discuss manners.

**Each individual is a potential benefit to himself and society.**

Activities

1. Develop the identity of the individual by having each child prepare a notebook with the following materials:
   a. Name on title page.
   b. Photographs or drawings of the individual.
   c. Photographs of individual in family group, in school group.
2. Help the individual discover his responsibility to self, home, community, nation and world.
   a. Discuss care of self (sleep, food, cleanliness, safety, etc.).
   b. Have children list ways in which they can contribute to community, such as keeping desks and school grounds clean, and not littering at home or in public places. Do not throw waste "down," always throw it "in."
   c. Demonstrate the responsibilities of voting by asking children to vote whether they like candy or meat and vegetables for dinner. They have a responsibility to choose meat and vegetables, since these make them healthier. Adults have a responsibility to vote for the candidate who will be best for society.
   d. Discuss people who render service to society. Examples; doctors, ministers, police, garage men, teachers, etc.

**Humans are the most important resource in nature because they can control the use of all resources.**

Activities

1. Discuss man's dependency on water, air, minerals, soil, plants and animals.
2. Prepare a bulletin board showing how man controls the use of other resources:
   a. Minerals—extraction regulations
   b. Air—pollution control
   c. Water—dams
   d. Soil—fertilization, contour farming
   e. Plants—farming and prevention of forest fires.
   f. Animals—scientific breeding and wildlife management.
3. Discuss methods of conservation and restoration—picking up trash, planting trees and flowers, saving injured animals, not wasting water, etc.
4. Discuss human conservation. Developing better humans improves the human resource.

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### Film and Filmstrips

(Films and filmstrips without sources listed will be found in the *Mountain Plain Film Library Association Joint Catalog* 62-64)

*Appreciating Our Parents,* 10 min.

*Fairness for Beginners,* 10 min.

*Johnny Learns His Manners,* 13 min.

*Let's Be Good Citizens in the Neighborhood,* 8 min.

*Safety with Everyday Tools,* 10 min.

*Safety on the Way to School,* 11 min.

# HUMAN RESOURCES -*Intermediate*

**Good physical health enhances the value of the individual as a human resource.**

ACTIVITIES

1. List major diseases and their preventions (if any). Discuss vaccination (polio, smallpox, etc.) as a means of preventing disease.
2. Prepare a report on the influence of Louis Pasteur on health. Discuss his contributions to vaccination and pasteurization.
3. Find out from U. S. Department of Labor the annual total number of persons unemployed because of bad health.
4. List ways in which students can improve their health (cleanliness, proper amount of sleep, good eating habits, exercise). Have students describe what happens to them when any one of the above is lacking in their daily routine.

**Personal health habits are directly related to community development.**

ACTIVITIES

1. Have children examine desks and lockers. Dirty desks and lockers make the school appear dirty. Unrepaired houses, dirty garages and badly-kept grounds make the city appear dirty.
2. List existing school and community betterment programs (clean-up, paint-up week, placing of trash barrels) and propose new projects.
3. Discuss the importance of neatness and city pride by using litter bags and litter barrels for all litter, even small paper wrappers. It is the habit and attitude that count.

**Abiding by the laws of safety is essential to the conservation of the human resource.**

ACTIVITIES

1. Assign groups in the class to make complete reports on:
   a. Safety at home.
   b. Safety in the school.
   c. Water safety.
   d. Fire safety.
   e. Safety on the road.
2. Invite members of the fire and police departments to speak on safety procedures.
3. Find out the number of people killed and injured in accidents each year.

**Conservation of all resources means cooperation and respect.**

ACTIVITIES

1. Explain Operation Respect, a program to promote better relations between landowners and hunters and fishermen. For information contact Colorado Game, Fish and Parks Department.
2. Discuss the ways in which individuals cooperating in a group can practice conservation (tree planting, fire fighting, anti-discrimination organizations).
3. Music can be correlated with conservation practices, composing songs.
4. Have students report on what democracy means to them. In a discussion stress the individual's responsibility to cooperate in achieving a common goal.

SPECIAL
SING
B# C#
SEEK
SAVE
NATURE SONGS
More NATURE SONGS

**Music is used at Remington School, Fort Collins, Colorado, to reinforce learning in a conservation activity.**

**The laws of nature apply to human life as well as other forms. In addition, man has the power of choice.**

ACTIVITIES

1. A retreat such as experienced in outdoor education classes can help children to plan their lives.

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### Films and Filmstrips

(Films and filmstrips without sources listed will be found in the *Mountain Plain Film Library Association Joint Catalog* 62-64)

*Am I Trustworthy?,* 10 min.

*Johnny Learns His Manners,* 13 min.

*Words of Courtesy,* 10 min.

### Other Aids

Colorado State Museum, E. 14th Avenue and Sherman Street, Denver, Colorado, *School Services Offerings* tells about tours and services at the museum.

A group of teachers at the Jefferson County Schools' Outdoor Education Laboratory above Evergreen, go over the interpretive trail they will be taking their classes over later.

# HUMAN RESOURCES - *Junior High*

Perfect Personality
Cooperative
honest
dependable
friend

**The human resource is similar to other natural resources in form and function.**

Activities

1. Compare humans to plants in regard to the need for food, adaptability to heat and cold, ability to reproduce.
2. Compare humans to other animals in the ability to make intelligent choices, formation of societies, and physiology.
3. Discuss man's ability to develop his body and his character in order to live a meaningful life.

**Man can choose his own course of action.**

Activities

1. Ask students to define an "individual." Each person has unique physical characteristics and a personality determined by his interaction with others. Emphasize that man has a "self" which he can direct.
2. Have students think of all decisions they make within an hour. Discuss what determines decisions. Compare the process by which the Supreme Court makes a decision with an individual's choice to go to a movie. Discuss how a person's judgment affects his life.
3. Conduct controlled experiments demonstrating that animals within limitations can learn to make choices. Compare conditioned responses of animals with those of humans.
4. Discuss the choices offered to an individual in a free society and in a police state. In a dictatorship state, decree determines what a person may or may not do. Have children describe situations where they have "followed the crowd." Emphasize a person's responsibility to make wise personal decisions regardless of what the group does.

**Improvement in the individual results in the improvement of the human resource.**

Activities

1. Have students write brief and concise definitions of "self-respect," "cooperation," "responsibility," "honesty," "dependability," "morality." Discuss definitions in class and construct a perfect (and imaginary) personality.
2. Discuss habits and how they affect physical appearance and character. List bad habits; discuss habits which cannot be broken.
3. Trace the progression from self-respect to respect for others. Conservation is the expression of self-respect and mutual respect.

**Individuals can practice conservation through self-respect, respect for natural resources, and respect for other people.**

Activities

1. Organize a junior conservation club modeled after the Morgan Junior Conservation Club in Fort Morgan, Colorado.
    a. Ask interested students to develop a concise statement of purpose. Leaders will emerge from this discussion.
    b. Elect a president, vice-president, secretary and treasurer. The best officers will be the ones most qualified to carry out the statement of purpose.
    c. Plan a series of constructive projects such as cleaning up parks, planting trees, rebuilding picnic areas.
    d. Enlist help of parents and members of the community whenever possible. A successful conservation club involves all persons who are capable of practicing conservation.
    e. For more information see the pamphlet *Conservation Clubs for Juniors,* published by the National Wildlife Federation or consult Herbert Hockstrasser, sponsor of the Morgan Junior Conservation Club, Ft. Morgan, Colorado.
2. Investigate existing local and national conservation organizations (National Wildlife Federation, Colorado Wildlife Federation, Operation Respect, Inc., Izaak Walton League, Soil Conservation Districts). Discuss their activities and objectives. Can students belong to these organizations?

**Young people should develop an appreciation for the wise use of time.**

Activities

1. Explain activities to utilize "wasted" summer hours. Examples include conservation groups, 4-H clubs, boy and girl scout groups, summer bands, summer study, reading, summer book clubs, swimming lessons, etc.
2. Stress that time in school should be utilized fully; figure the time wasted by persons each day through careless planning of activities.

**Vocational guidance services should be understood by all youngsters.**

Activities

1. Find out publications available in the school library which describe occupations.
2. Make a list of persons or agencies which have information on vocational guidance.
3. Find out the implications of automation on jobs in the future. What types of jobs are being eliminated through automation?
4. Discuss reasons for making a career selection fairly early in life.

## BIBLIOGRAPHY

### Books and Pamphlets

Ashaugh, Byron and Beuschlein, Muriel. *Things to Do—In Science and Conservation.* Danville, Ill.: The Interstate Printers, 1960.

Baxter, Laura and others. *Sharing Family Living.* Philadelphia: J. B. Lippincott Co., 1951.

Beauchamp, Wilbur L. *Basic Studies in Science.* Chicago: Scott, Foresman and Co., 1956.

Blackburn, Edith H. *The Bells of Carmel.* New York: Aladdin Books, 1955.

———. *One Bit of Land.* New York: Aladdin Books, 1954.

———. *Land of the Silver Spruce* (Colo.). New York: Abelard-Schuman, Inc., 1956.

Clark, Nadine I. and others. *Civics for Americans.* Chicago: Macmillan.

Cocannouer, Joseph A. *Water and the Cycle of Life.* New York: Devin-Adair Company, 1958.

Cullen, Allen H. *Rivers in Harness.* Philadelphia: Chilton, 1962.

Frandsen, Maude Lindstrom. *High in the Rockies.* Boulder, Colo.: Johnson Publishing Co., 1959.

———. *Our Colorado.* Denver: Old West Publishers, 1959.

———. *Sixty and Three on the Flying "C".* Boulder, Colo.: Johnson Publishing Co., 1959.

Heffernan-Shaftel. *Man Improves His World.* Syracuse: Singer and Co., 1963.

Jenkins, Gladys G. and others. *Teenagers.* Chicago: Scott, Foresman Co.

Johnson, H. Nat and Poatgieter, Alice H. *Outdoors.* Boston: Houghton Mifflin Co., 1957. 188 p.

Johnson, James Ralph. *Anyone Can Live Off the Land.* New York: Longman's Green, 1961.

Munzer-Brandwein. *Teaching of Science Through Conservation.* New York: McGraw-Hill, 1960.

Parker, Bertha M. *Leaves.* Evanston, Ill.: Row Peterson and Co., 1951.

Phillips, Glen H. *Colorado, Your State and Mine.* Boulder, Colo.: Pruett Press, 1962.

Reavley, William L. *Conservation Clubs for Juniors.* Washington: National Wildlife Federation.

Riedman, Sarah R. *Water for People.* New York: Abelard-Schuman, 1960.

Rocky Mountain Forest and Range Experiment Station. *Annual Report.* Fort Collins, Colo.: Colorado State University.

Schacter, Helen and others. *Into Your Teens.* Chicago: Scott, Foresman, 1959.

Smith, Harriet F. and others. *Your Life as a Citizen.* Boston: Ginn and Co., 1958.

Swift, Ernest. *The Glory Trail.* Washington: The National Wildlife Federation.

U. S. Department of Health and Welfare. *Conservation Experiences for Children.* Bulletin 1957—No. 16. Washington: the Department.

### Films and Filmstrips

(Films and filmstrips without sources listed will be found in the *Mountain Plain Film Library Association Joint Catalog* 62-64)

*Act Your Age,* 13 min.

*Acts of Courtesy,* 9 min.

*Appreciating Our Parents,* 10 min.

### Other Aids

*The Curious Naturalist* (monthly, $1.50 per year) is published by the Massachusetts Audubon Society, South Lincoln, Massachusetts.

# APPENDIX

## Appendix I—General Bibliography

Allen, Durward L. *Our Wildlife Legacy*. New York: Funk & Wagnalls Co., 1962. (Rev.) 422 p.

This describes the history, use, and management of American resources of birds, mammals, and fish, and outlines the biological principles of wildlife conservation.

American Association of School Administrators. *Conservation in the American Schools.* Twenty-ninth Yearbook. Washington, D.C.: the Association, 1951.

Ashbaugh, Byron L. and Beuschlein, Muriel. *Things to Do in Science and Conservation.* Danville, Ill.: The Interstate Printers and Publishers, 1960. 163 p.

Chapters cover the traditional renewable and non-renewable resources and for the first time include space, air, sunlight, and man-developed resources such as electricity, synthetics, and nuclear energy.

Bathurst, Effie G. *Conservation Experiences for Children.* Washington, D.C.: Superintendent of Documents, U. S. Government Printing Office, 1957. 192 p.

This bulletin is a compilation of curriculum experiences which boys and girls have with natural resources, on which the nation's economy and ways of living depend.

Bauer, Helen. *Water: Riches or Ruin.* New York: Doubleday & Co., 1959. 121 p.

All about conservation with emphasis on water conservation. Describes interrelationship of water to other resources and practices in the management of water and land in watersheds that supply cities.

Beard, Ward P. *Teaching Conservation—A Guide in Natural Resource Education.* Washington, D.C.: The American Forestry Association, 1948. 144 p.

Designed especially to provide teachers with the basic understanding for effective teaching of conservation in the school, this book sets forth (1) a proper concept of conservation by use of certain facts about natural resources and (2) the educational principles to be followed in using natural resource information to give students an understanding of conservation.

Brown, Harrison. *The Challenge of Man's Future.* New York: The Viking Press, 1954. 250 p.

Expression of ideas on the limitations of the earth, and on the potential and the relationship of technology for maintaining an adequate supply of mineral resources.

Carhart, Arthur H. *The National Forests.* New York: Alfred A. Knopf, 1959. 289 p.

A word and picture tour of the more than 180,000,000 acres that constitute our national forests.

———. *Water—or Your Life.* New York: J. B. Lippincott Company, 1951. 312 p.

What to do and what to avoid in maintaining appropriate distribution of water.

Clawson, Marion; Held, Burnell; and Stoddard, Charles H. *Land for the Future.* Baltimore: The John Hopkins Press, 1960. 672 p.

Considers the changing uses of land in the past, the present, and in the light of expectations extending to the year 2000.

Colby, C. B. *Snow Surveyors, Defenders Against Flood and Drought.* New York: Coward-McCann, 1959. 48 p.

This is a pictorial story about men of the Soil Conservation Service and cooperating agencies who each winter go into the high mountains of the West and Northwest to measure the vast reservoirs of snow to determine the amount of water that will be available the following summer month.

———. *Soil Savers, The Work of the Soil Conservation Service.* New York: Coward-McCann, 1957. 48 p.

A pictorial presentation of wind and water erosion and what is being done to combat the problem. Tells how the Soil Conservation Service and soil conservation districts were formed and how they work with farmers and ranchers in carrying out made-to-order soil and water conservation programs.

Coyle, David Cushman. *Conservation: An American Story of Conflict and Accomplishment.* New Brunswick, N.J.: Rutgers University Press, 1957. 284 p.

Dale, Tom and Carter, Vernon Gill. *Topsoil and Civilization.* Norman, Okla.: University of Oklahoma Press, 1955. 270 p.

An account of civilized man's dependence upon the fertility of the soil for nurture and sustenance and how his use or misuse of the land has influenced the course of world history more than any other single factor.

Earth Science Curriculum Project, *Geology and Earth Sciences Source Book for Elementary and Secondary Schools.* New York: Holt, Rinehart and Winston, Inc., 1963.

A source book for teachers.

Farb, Peter. *Living Earth.* New York: Harper & Brothers, 1959. 178 p.

An interesting and readable, yet scientifically accurate, discussion of life in the soil.

Fox, William. *Rocks and Rain and the Rays of the Sun.* New York: Henry Z. Walck.

About the work of raindrops, rays of the sun, the soil and its products. A simple introduction to geology, use and conservation of soil, water, grass, forests, minerals, and oil.

Frank, Bernard and Netboy, Anthony. *Water, Land and People.* New York: Alfred A. Knopf, 1950. 331 p.

Presents the land and water problems of the United States from the standpoint of disturbed biological conditions in river basins.

Helfman, Elizabeth S. *Land, People, and History.* New York: David McKay Company, 1962. 271 p.

Deals with the importance of land and the effect of its use and misuse on man throughout history. The book seeks to provide a basic understanding of the use of the land and what must be done to maintain the fertility of the land and prevent it from being wasted.

Higbee, Edward. *American Agriculture: Geography, Resources, Conservation.* New York: John Wiley & Sons.

A comprehensive survey of the agriculture of the United States. A graphic account of the soil and water resources, defining their location, uses, and methods of conservation.

———. *The American Oasis.* New York: Alfred A. Knopf, 1958. 262 p.

A complete account of the way man has treated the soil from colonial times to the present.

———. *The Squeeze: Cities Without Space.* New York: William Morrow and Co., 1960. 384 p.

A book useful as collateral reading in high school courses dealing with modern problems arising out of population growth and urbanization.

Hill, Wilhelmina. *The Three R's and Resources.* Washington, D.C.: National Wildlife Federation, 1959. 10 p.

Written by a specialist for social science in the U. S. Office of Education, this publication points out the highlights in the need for teaching conservation, enlisting public support and getting the job done.

Hubbard, Alice Harvey. *This Land of Ours—Community and Conservation Projects for Citizens.* New York: The Macmillan Co., 1960. 272 p.

More than 180 community and conservation projects are detailed, with every state and region represented. Projects cover such matters as guarding our heritage of natural beauty, roadside beautification, community planning, and

recreational facilities, special gardens and sanctuaries, soil and water conservation, and many others.

Joy, Charles R. *Race Between Food and People: The Challenge of a Hungry World.* New York: Coward-McCann, 1961. 121 p.

A story about worldwide hunger and what man is trying to do to support increasing numbers of men. Soil and water conservation, new foods for old, and the friendly atom are helping to meet the world's need.

Keirstead, Ralph E. *We Look To Our Future.* Hartford, Conn.: Greater Hartford Council on Economic Education, 1956. 44 p.

A look at our natural resources and why they are important. The resources—soil, water, minerals, and man—are included in this well-illustrated booklet.

Kellogg, Charles E. *The Soils That Support Us.* New York: The Macmillan Co., 1941. 370 p.

An introduction to the soils and their use by people. How soil is made and its many forms and types.

King, Thomson. *Water.* New York: The Macmillan Company, 1955. 238 p.

The story of what water, in all its forms, has done to the world and life. Part of the book deals specifically with soil erosion, water pollution, etc.

Leopold, Aldo. *A Sand County Almanac.* New York: Oxford University Press, 1949. 239 p.

A collection of essays in beautifully written prose by one of the world's great naturalists, expressing his appreciation of the way of life of all wild things.

Moore, Alma Chesnut. *The Grasses: Earth's Green Wealth.* New York: The Macmillan Co., 1960. 150 p.

This book deals chiefly with those grasses which produce the seeds or grains which are the basis of our starch foods and which play an indirect part in the production of meat and dairy products.

Munzer, Martha E. and Brandwein, Paul F. *Teaching Science Through Conservation.* New York: McGraw-Hill, 1960. 470 p.

This book brings together conservation ideas and concepts and demonstrates how they may be presented in high school science classes. It can help to accomplish integration of conservation activities into existing courses such as general science, chemistry, and physics, as well as biology.

National Association of Biology Teachers. *Materials for Teaching Conservation and Resource-Use.* Danville, Ill.: The Interstate Printers and Publishers, 1958. 55 pp.

A comprehensive listing of the free and inexpensive printed and audio-visual materials available to teachers in the field of conservation and resource-use.

National Conservation Committee of The National Association of Biology Teachers. *The Conservation Handbook.* Danville, Ill.: The Interstate Printers and Publishers, 1958. 499 p.

Designed to help teachers get started on the important job of teaching conservation in both elementary and secondary schools.

Osborn, Fairfield. *Our Plundered Planet.* Boston: Little, Brown, and Co., 1958. 217 p.

A thought-provoking book on the use and misuse of the earth by man. One by one the author points out sections of the different continents where deserts have been made out of fertile land and where destruction is already complete.

Massachusetts Audubon Society. *The Curious Naturalist.* (Published 10 times yearly.) South Lincoln, Mass.: the Society.

Packard, Vance. *The Waste Makers.* New York: David McKay Co., 1960. 340 p.

A story about the "philosophy of waste"; tells who the waste makers are, how they operate, and what they do to us. Describes the impact on America's dwindling natural resources.

Parson, Ruben L. *Conserving American Resources.* Englewood Cliffs, N.J.: Prentice-Hall, 1956. 550 p.

A comprehensive presentation of all the renewable resources—soil, water, grasslands, forests, and wildlife. Recreational resources are given proper emphasis.

Perry, John and Greverus, Jane. *Exploring the River.* New York: McGraw-Hill Book Co., 1960. 203 p.

The authors, through the medium of a hypothetical exploring trip, present the message of conservation of water and soil resources and the part that a river and a watershed plays in the world and discuss its relationship and effect on various aspects of life.

Phillips, Glen H. *Colorado, Your State and Mine.* Boulder, Colo.: Pruett Press, 1962.

A history of Colorado.

Riedman, Sarah. *Water for People.* New York: Abelard-Schuman Limited, 1961. 176 p.

A story about water and water problems—how people learned to store it in mains, reservoirs, and wells; how they learned to use it for travel, power, and irrigation.

Roberts, Edd. *Land Judging.* Norman, Okla.: University of Oklahoma Press, 1955. 120 p.

A guide to land judging as a means of evaluating land capability and soil and water conservation needs.

Sears, Paul B. *Deserts on the March.* Norman, Okla.: University of Oklahoma Press, 1954. 178 p.

Emphasizes the problem of conservation within the framework of the whole social and political order. Touches on the historical past and then details the regional use of American land, especially as it results from social causes.

Stead, William H. *Natural Resource Use in Our Economy.* New York: Joint Council on Economic Education, 1960. 88 p.

A well-illustrated booklet dealing with the subject: How can we manage our renewable and non-renewable resources wisely enough to maintain a high standard of living?

Treat, Dorothy A. *Nature Program Guide—Projects, Games, Activities for Audubon Junior Clubs.* New York: National Audubon Society, 1953. 88 p.

Contents include instruction on soil and water exploration, erosion control, field trips, wildlife habitats, plants, mammals and nature games. An extensive annotated bibliography is especially valuable to teachers.

Udall, Stewart L., U. S. Department of Interior. *Natural Resources of Colorado.* Washington, D.C., 20402: Superintendent of Documents, Government Printing Office, 1963. 50 cents.

U. S. Department of Agriculture. *After a Hundred Years.* 1962 Yearbook. Washington, D.C.: Superintendent of Documents, Government Printing Office, 1962. 688 p.

An interesting story about the first 100 years of the United States Department of Agriculture. This book, unlike previous Yearbooks, is addressed more to non-farmers than to farmers. History of agriculture and the Department, research, land-grant institutions, plant science, forests, soil and conservation, and insects are only a few of the many highlights of this book.

———. *Food.* 1959 Yearbook. Washington, D.C.: Superintendent of Documents, Government Printing Office, 1959. 736 p.

Explains everything that is up-to-date and scientifically sound about food in our lives. Tells how we produce and prepare food, protect its quality and purity, and share it with others; how to be well-nourished.

———. *Grass.* 1948 Yearbook. Washington, D.C.: Superintendent of Documents, Government Printing Office, 1948. 892 p.

A comprehensive book about a crop of importance to everyone. Major sections include grass in a permanent agriculture; grass and conservation; forage for livestock; and how to grow grass in all parts of the country .

———. *Insects.* 1952 Yearbook. Washington, D.C.: Superintendent of Documents, Government Printing Office, 1952. 942 p.

The 131 chapters of this book tells all about insects. Seventy-two color plates illustrate groups of insects commonly found in the United States.

———. *Land.* 1958 Yearbook. Washington, D.C.: Superintendent of Documents, Government Printing Office, 1958. 686 p.

Information on such topics as vast public domain—the increasing sizes of farms and our declining farm population—zoning and planning—our future need for food and fiber—conservation, etc.

———. *Soil.* 1957 Yearbook. Washington, D.C.: Superintendent of Documents, Government Printing Office, 1957. 784 p.

Information on the principles of soils, fertility, conservation, moisture, cropping systems, special uses, etc.

———. *Trees.* 1949 Yearbook. Washington, D.C.: Superintendent of Documents, Government Printing Office, 1949. 944 p.

Tells how and why to plant trees and care for them. Explains the essentials of choosing, planting, and growing trees as a farm crop, as a renewable natural resource, etc.

———. *Water.* 1955 Yearbook. Washington, D.C.: Superintendent of Documents, Government Printing Office, 1955. 725 p.

Covers water and soil conservation; irrigation; industry's need for water; water pollution; weather cycles; floods; water and wildlife; safe water supplies; and water laws.

Vogt, William. *Road to Survival.* New York: William Sloane Associates, 1948. 355 p.

Presents in dramatic fashion man's abuse of the world's resources and its special significance for Americans.

Weaver, Richard L., (ed.). *Manual for Outdoor Laboratories.* Danville, Ill.: Interstate Printers and Publishers, 1959. 88 p.

This manual compiles articles that contain practical suggestions for teaching science and conservation by numerous succesful teachers of conservation from all levels of education.

Weaver, Richard L., (compiler). *Conservation Handbook.* Prepared by the National Conservation Committee of the National Association of Biology Teachers. Danville, Ill.: Interstate Printers and Publishers, Inc., 1955. 410 p.

## Appendix II—Bibliographies

Beuschlein, M. *Free and Inexpensive Materials for Teaching Conservation and Resource Use.* Danville, Ill.: Interstate Printers and Publishers.

Conservation Education Association. *Selected References on Conservation Education for Teachers and Pupils.* Billings, Mont.: Eastern Montana College, 1953.

The Conservation Foundation, Audio-Visual Department, (compilers and editors). *A Critical Index of Films and Filmstrips in Conservation.* New York: the Foundation, 1961.

The Conservation Foundation. *List of Films, Pamphlets and Books.* New York: the Foundation.

Joint Council on Economic Education. *Annotated Bibliography of Materials in Economic Education.* New York: the Council, 1960. 45 p.

## Appendix III—Other Aids

National organizations where printed materials in Conservation are provided:

Chamber of Commerce of the United States
1615 H Street, N.W.
Washington, D.C.

Conservation Foundation, Inc., The
30 East 40th Street
New York 16, New York

Friends of the Land
1368 North High Street
Columbus 1, Ohio

Keep America Beautiful, Inc.
99 Park Avenue
New York 16, New York

Keep Denver Beautiful Committee
Denver Chamber of Commerce
1301 Welton Street
Denver 2, Colorado

National Association of Soil Conservation Districts
League City, Texas

National Audubon Society
1000 Fifth Avenue
New York 28, New York

National Conference on State Parks
901 Union Trust Building
Washington 5, D.C.

National Grange, The
744 Jackson Place, N.W.
Washington 6, D.C.

National Parks Association
1214 16th Street, N.W.
Washington 6, D.C.

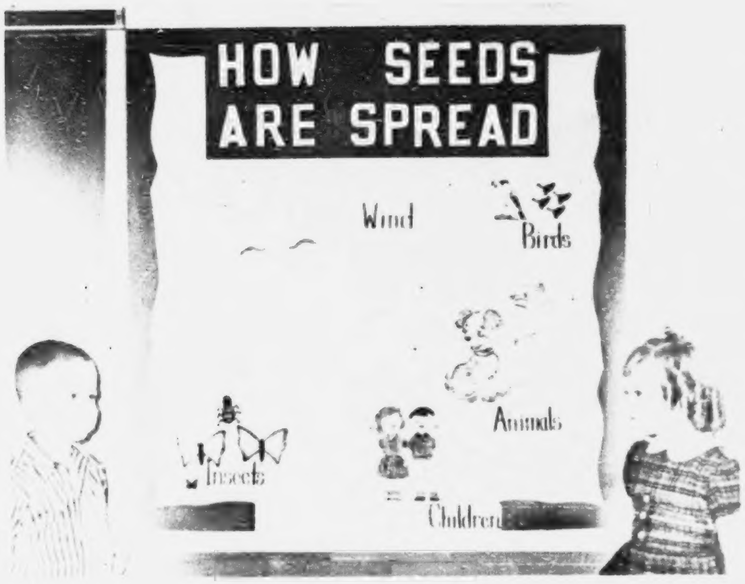
National Wildlife Federation
3308 14th Street, N.W.
Washington 10, D.C.

Natural Resources Council of America
822 Investment Building
Washington 5, D.C.

United States Department of the Interior
Bureau of Reclamation
Office of Assistant Commissioner and Chief Engineer
Building 53, Denver Federal Center
Denver, Colorado 80225

Wilderness Society, The
1840 Mintwood Place, N.W.
Washington 9, D.C.

Wildlife Management Institute
709 Wire Building
Washington 5, D.C.


HOW SEEDS ARE SPREAD
Wind
Birds
Animals
Insects
Children

Conservation education can start in any grade. A display used in the kindergarten of Chamberlin School in El Paso County School District 2 (Harrison), Colorado Springs, is shown above.

WATER
ONERS

This scene from the film "Water More Precious Than Gold" shows students from Denver's Hill Junior High preparing to tour the headquarters of the Denver Water Board.

The Future Farmers of America exhibit shown below won first prize in a state meeting of Soil Conservation Districts.

WATER CONSERVATION
1ST PRIZE
BY
UNDERGROUND RECHARGING
COLORADO

# Conservation Pledge

I GIVE MY
PLEDGE AS AN AMERICAN
TO SAVE AND FAITHFULLY TO
DEFEND FROM WASTE THE
NATURAL RESOURCES OF
MY COUNTRY—ITS SOIL
AND MINERALS, ITS
FORESTS, WATERS,
AND WILDLIFE